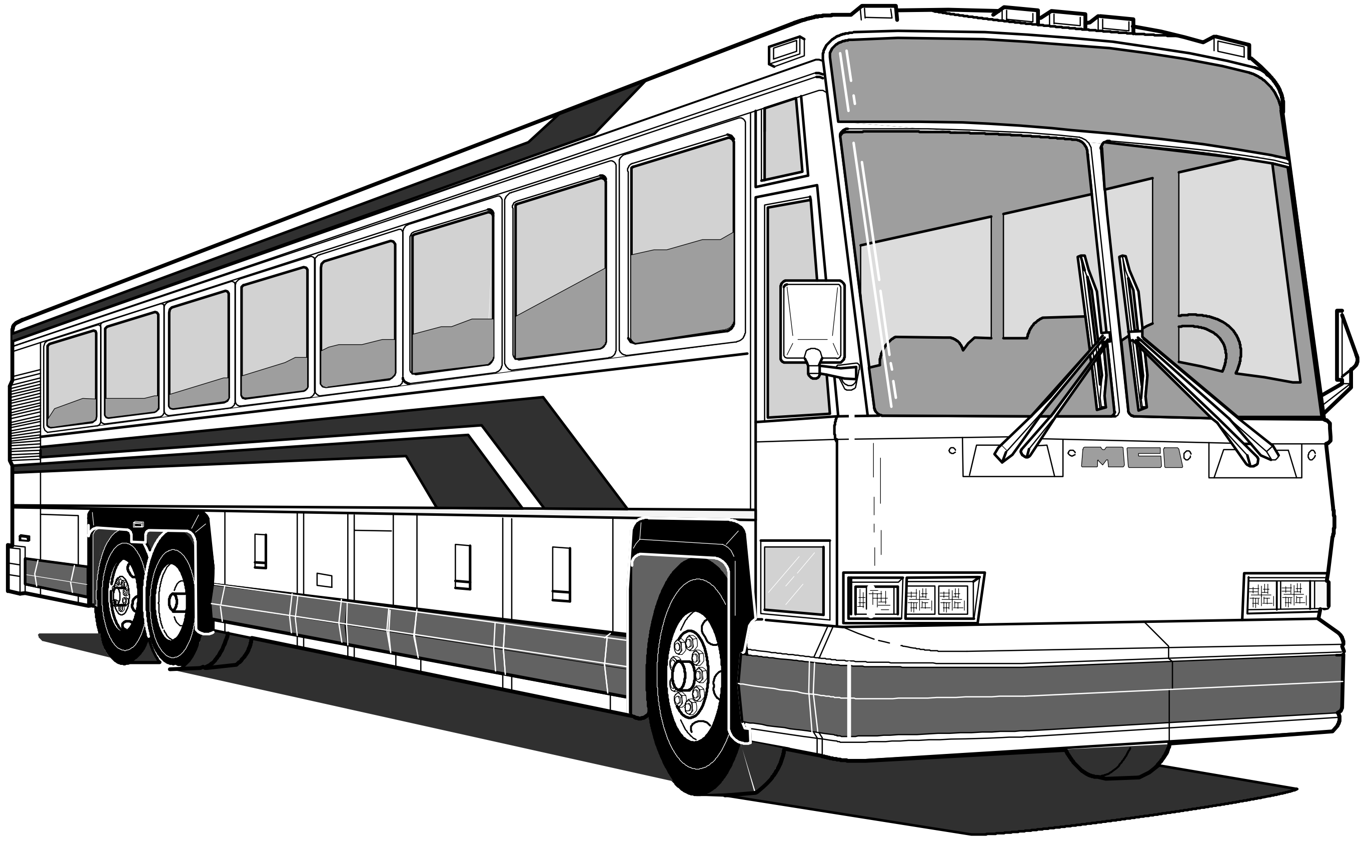
102D SERIES MAINTENANCE MANUAL

INTERCITY COACH MODELS 102D3, 102DL3, 102DLS3



MOTOR COACH INDUSTRIES INC.
PEMBINA, NORTH DAKOTA, U.S.A. 58271-1088

MOTOR COACH INDUSTRIES INC.
WINNIPEG, MANITOBA, CANADA R3G0J8

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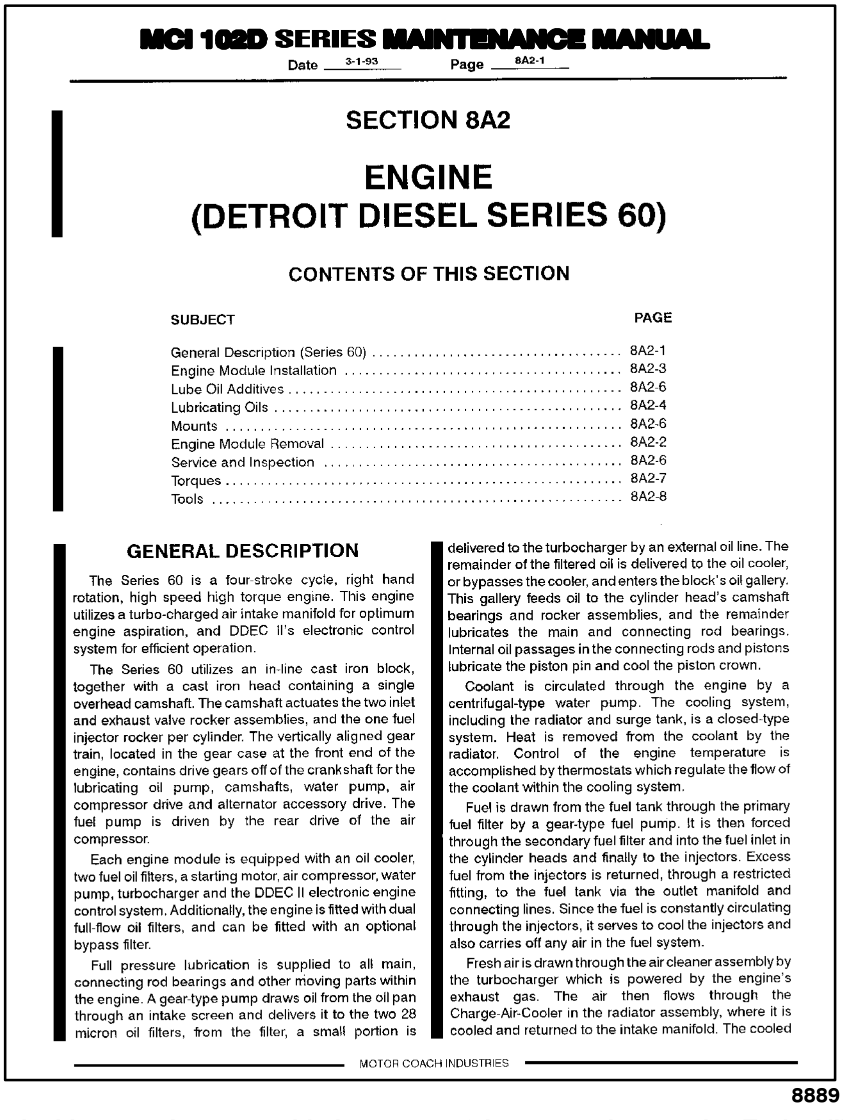
INTRODUCTION

This manual contains information on systems operation, component location, periodic maintenance and overhaul procedures, which pertains to standard and commonly used optional equipment on MCI 102D series coach models. Proper maintenance is important to the safe and reliable operation of all MCI Model coaches. The service procedures described and/or recommended in this manual are effective methods for performing routine service or replacement of components. Other information which may be needed to supplement this manual is contained in separate parts and operator's manuals. Specific information about the engine and transmission can be found in the applicable manufacture's service and troubleshooting manuals.

HOW TO USE THIS MANUAL

The maintenance manual is divided into major sections similar in sequence to the parts manual as shown on the section index. Some of these major sections may be divided into smaller subsections dealing with specific components and/or operating systems. A general TOC appears on the first page of each divided section detailing the subsection breakdown and page designators. Find and turn to the subsection which contains the information being sought. A detailed TOC appears on the first page which often shows the topics: (General Description, Components, Operation, Maintenance and Specifications) to quickly direct you to the specific area of inquiry. Manufacturer's model or part number, component service data and tolerances, specialized tools, torque specifications, when available, are listed at the end of the sections. MCI service part numbers for some components appear at the end of sections as a convenient reference. These part numbers should always be verified through the latest revision of the MCI 102D Series Parts Manual. A detailed alphabetical-to-page index is also provided at the back of the manual. Manual pages and illustrations are numbered consecutively within each section or subsection designator.



MCI 102D SERIES MAINTENANCE MANUAL

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SECTION 8A2

ENGINE
(DETROIT DIESEL SERIES 60)

CONTENTS OF THIS SECTION

SUBJECT PAGE

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GENERAL DESCRIPTION

The Series 60 is a four-stroke cycle, right hand rotation, high speed high torque engine. This engine utilizes a turbo-charged air intake manifold for optimum engine aspiration, and DDEC II's electronic control system for efficient operation.

The Series 60 utilizes an in-line cast iron block, together with a cast iron head containing a single overhead camshaft. The camshaft actuates the two inlet and exhaust valve rocker assemblies, and the one fuel injector rocker per cylinder. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshafts, water pump, air compressor drive and alternator accessory drive. The fuel pump is driven by the rear drive of the air compressor.

Each engine module is equipped with an oil cooler, two fuel oil filters, a starting motor, air compressor, water pump, turbocharger and the DDEC II electronic engine control system. Additionally, the engine is fitted with dual full-flow oil filters, and can be fitted with an optional bypass filter.

Full pressure lubrication is supplied to all main, connecting rod bearings and other moving parts within the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the two 28 micron oil filters, from the filter, a small portion is delivered to the turbocharger by an external oil line. The remainder of the filtered oil is delivered to the oil cooler, or bypasses the cooler, and enters the block's oil gallery. This gallery feeds oil to the cylinder head's camshaft bearings and rocker assemblies, and the remainder lubricates the main and connecting rod bearings. Internal oil passages in the connecting rods and pistons lubricate the piston pin and cool the piston crown.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the primary fuel filter by a gear-type fuel pump. It is then forced through the secondary fuel filter and into the fuel inlet in the cylinder heads and finally to the injectors. Excess fuel from the injectors is returned, through a restricted fitting, to the fuel tank via the outlet manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine's exhaust gas. The air then flows through the Charge-Air-Cooler in the radiator assembly, where it is cooled and returned to the intake manifold. The cooled

MOTOR COACH INDUSTRIES

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NOTE: Some illustrations in this manual were provided courtesy of the appropriate vendor. Typical illustrations may be used, therefore minor illustration differences may exist when compared to actual parts or other publications.

REVISIONS & SERVICE INFORMATION BULLETINS

This manual will on occasion be revised in order to add new information, and to update or correct existing information. Please note the bold vertical line (revision bars) that appear to the left of each text column on sample page below (Figure 1). The revision bars indicate changes made since the last printing. The revision bars can be used to show changes made within a specific sentence or paragraph, and in some instances they may extend throughout whole section, if required. The revision bars should allow the reader to quickly identify areas with new or different information. All information contained in this manual is based on the latest product information available at time of publication. Motor Coach Industries reserves the right to make product changes at any time without notice. Service Bulletins are issued, when required, to supplement or supersede information in this manual. Information in the bulletins should be noted and filed for future use.

CUSTOMER SERVICE

Universal Coach Parts, of Des Plaines, IL, and Motor Coach Industries, Ltd., Service Parts Division, of Canada, know your coach best and are interested in your complete satisfaction. Both offer genuine factory parts for this MCI Model and all other MCI Coach Models. Service departments in the U.S. and Canada stand ready to serve you. Their addresses are:

MCI Service Control Center
442 West Stutsman Street P.O. Box 528
Pembina, North Dakota 58271-0528
FAX: 701-825-6956

MCI Service Department
1475 Clarence Avenue
Winnipeg, Manitoba R3T 1T5
FAX: 204-452-6061

⚠ WELDING CAUTION ⚠

Since welding is a procedure which may be carried out either as allowed (explicitly or implicitly) by instructions in this manual or by an independent decision of the coach owner/operator, the following information pertaining to welding should be read before beginning any welding process. The prohibitions and requirements contained therein must be complied with when any coach welding is undertaken. **IMPORTANT:** In order to prevent electronic control component(s) damage during welding, steps 3 thru 5 must be strictly adhered to.

1. Welding must be done only by an experienced and qualified person (Minimum Requirements AWS B1.1). All specific instructions or prohibitions of applicable welding procedures must be followed.
2. Adequate ground contacts and barriers must be positioned as close as possible to the weld area and as required to protect components (wiring, brake lines, hydraulic lines, etc.) from damage due to heat, contact by weld splatter, arcing or other potentially damaging events associated with welding.
3. Turn the main battery disconnect switch to "OFF."
4. Protect the Vanner battery equalizer as follows:
    a. Disconnect the ground at the equalizer first.
    b. Disconnect the battery leads.
    c. Reconnect the battery leads first and equalizer ground last.
5. Remove the ATEC/WTEC/DDEC power control fuses, and disconnect harnesses from their ECM and ECU units.

⚠ DRILLING CAUTION ⚠

Due to the close proximity of Electrical/Mechanical lines to the aisle floorboard DO NOT drill any holes in the center tunnel area. This area is 15 inches wide and runs immediately under the coach center aisle for the full length of the coach.

Various other WARNINGS, CAUTIONS and NOTES are contained in this manual. They should be read carefully to minimize the risk of personal injury or the possibility that improper service methods may be used which could damage the coach and render it unsafe. It is important to note that these cautions and notices are not all inclusive. We could not evaluate and advise users of all conceivable ways in which service may be done or of the possible hazardous consequences of each way. We have not attempted to do this. Therefore, anyone who uses a service procedure or tool not recommended by the manufacturer should first satisfy himself that neither his safety nor vehicle safety will be jeopardized by the particular method he selects.

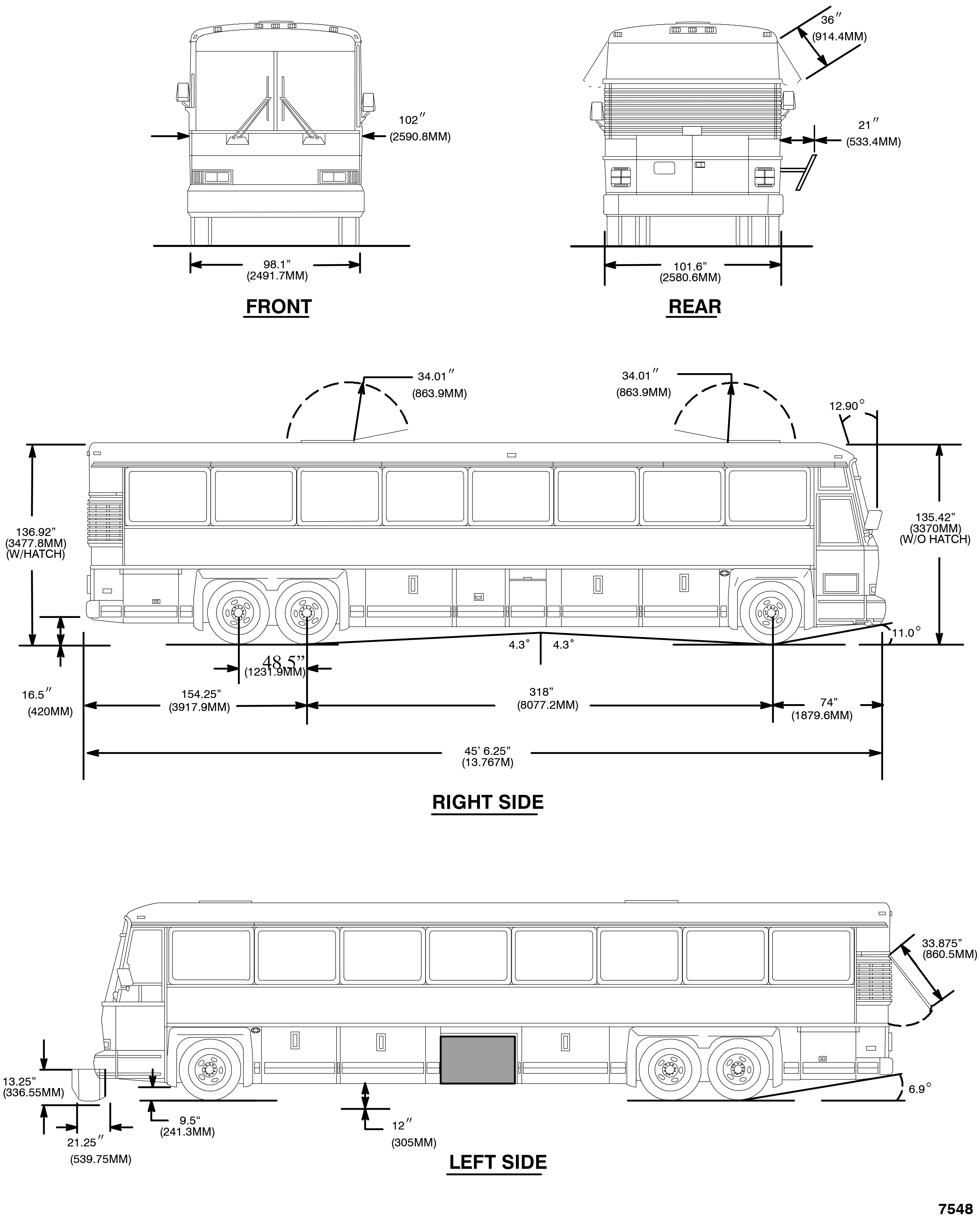

102″
(2590.8MM)
98.1”
(2491.7MM)
FRONT
36″
(914.4MM)
21″
(533.4MM)
101.6”
(2580.6MM)
REAR
34.01″
(863.9MM)
34.01″
(863.9MM)
12.90°
136.92”
(3477.8MM)
(W/HATCH)
135.42”
(3370MM)
(W/O HATCH)
11.0°
4.3°
4.3°
48.5”
(1231.9MM)
16.5″
(420MM)
154.25”
(3917.9MM)
318”
(8077.2MM)
74”
(1879.6MM)
45’ 6.25”
(13.767M)
RIGHT SIDE
33.875”
(860.5MM)
6.9°
13.25”
(336.55MM)
21.25″
(539.75MM)
9.5“
(241.3MM)
12″
(305MM)
LEFT SIDE
7548

Figure 1. 102DL3 Model Body and Door Clearance Diagram

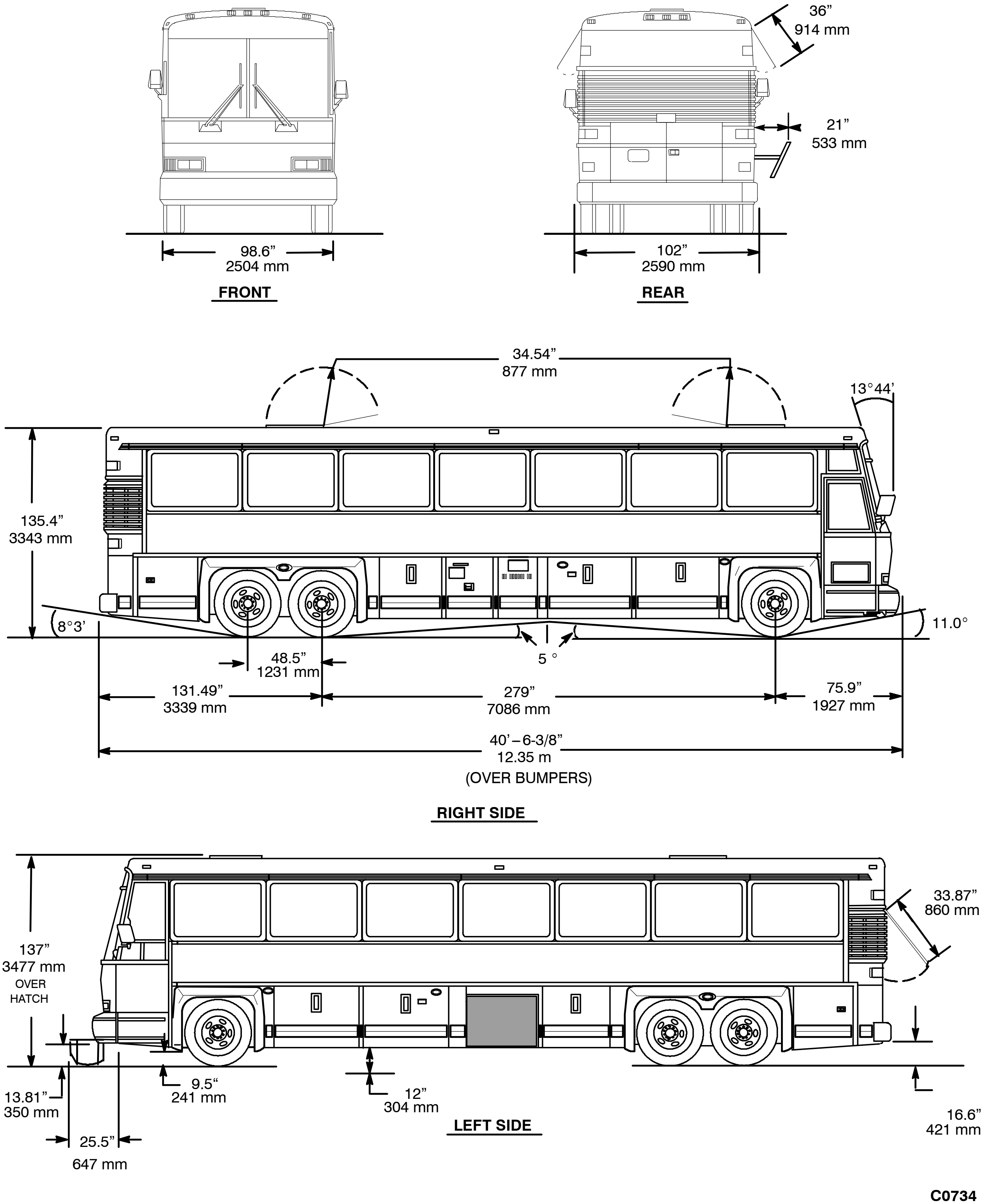

36”
914 mm
21”
533 mm
98.6”
2504 mm
FRONT
102”
2590 mm
REAR
34.54”
877 mm
13°44’
135.4”
3343 mm
8°3’
11.0°
48.5”
1231 mm
5 °
131.49”
3339 mm
279”
7086 mm
75.9”
1927 mm
40’–6-3/8”
12.35 m
(OVER BUMPERS)
RIGHT SIDE
33.87”
860 mm
137”
3477 mm
OVER
HATCH
13.81”
350 mm
9.5“
241 mm
12”
304 mm
LEFT SIDE
16.6”
421 mm
25.5”
647 mm
C0734

Figure 2. 102D3 Model Body and Door Clearance Diagram

GENERAL DATA

The data below includes only general information on coach models covered by this manual.

VEHICLE LENGTH: (102DL3) Over Bumpers	45’-6$^{1}/_{4}$” (13.87 m)
VEHICLE LENGTH: (102D3) Over Bumpers	40’-6$^{3}/_{8}$” (12.35 m)
VEHICLE HEIGHT: (102D3 & 102DL3) Top of Roof Hatch	136.92” (3477.8 mm)
VEHICLE HEIGHT: (102DLS3) Top of Roof Hatch	139.92” (3554 mm)
VEHICLE WIDTH: (102D3 & 102DL3)	102” (2590.8 mm)
TURNING RADIUS: (102DL3)	
RH TURN (At Front Bumper)	45’-0” (13.71 m)
LH TURN (At Front Bumper)	46’-6” (14.17 m)
RH TURN (At Tire)	41’-0” (12.50 m)
LH TURN (At Tire)	42’-9” (13.03 m)
TURNING RADIUS: (102D3)	
RH TURN (At Front Bumper)	44’-8” (15.37 m)
LH TURN (At Front Bumper)	44’-9” (15.37 m)
RH TURN (At Tire)	40’-9” (15.37 m)
LH TURN (At Tire)	40’-9” (15.37 m)
WHEELBASE: (102DL3) Front Axle to Drive Axle Centers	318” (8077.2 mm)
WHEELBASE: (102D3) Front Axle to Drive Axle Centers	279” (7087 mm)
FRONT AXLE TRACK:	85.6” (2174 mm)
REAR AXLE TRACK: (Center of Dual Wheels)	76.6” (1946 mm)
TRAILING AXLE TRACK:	85.6” (2174 mm)
GROSS VEHICLE WEIGHT: (102D3 & 102DL3)	44,400 lbs. (20,139.8 kg)
APPROXIMATE PAYLOAD CAPACITY: (102DL3)	12,750 lbs. (12358.3 kg)
APPROXIMATE PAYLOAD CAPACITY: (102D3)	11,500 lbs. (12358.3 kg)
FUEL CAPACITY: (Standard Tank)	192 Gal. U.S. (726.7 liters)
COOLING SYSTEM CAPACITY: (With 8V-92 Installations)	32.5 Gal. U.S. (123 liters)
COOLING SYSTEM CAPACITY: (With Series 60, Caterpillar or Cummins Installations)	28 Gal. U.S. (123 liters)
STEERING SYSTEM CAPACITY:	7.5 Qts. U.S. (7.1 liters)
TIRE SIZE: (Minimum)	“H” Rated

See the capacity schedule in Section 10 for further information on engine, transmission and rear axle lube capacities.

ENGINE DATA

Model	**8V-92**	**Series 60**	**Cummins**	**Caterpillar**
Type	2 Cycle	4 Cycle	4 Cycle	4 Cycle
No. of Cylinders	8	6	6	6
Bore (Inches)	4.84	5.12	4.92	4.92
Bore (mm)	123	130	125	125
Stroke (Inches)	5	6.3	5.78	5.5
Stroke (mm)	127	160	147	140
Compression Ratio (Turbo)	17:1	15:1	16:1	16:1
Total Displacement (Cubic Inches)	736	775	661	628
Total Displacement (Liters)	12.07	12.7	10.8	10.3
No. of Main Bearings	5	7	7	7

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 1

FRONT AXLE

Printed in U.S.A.

SECTION 1

FRONT AXLE

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	1-1
Lubrication	1-2
Maintenance	1-3
Troubleshooting	1-15
Torque Specifications	1-17
Specifications	1-18
Service Tools	1-19

GENERAL DESCRIPTION

The 102 D series coaches use the Rockwell "Easy Steer" type front axle assembly. The front axle is designed and rated at 14,400 GVWR. These axles are non-drive, "Reversed Elliott" style, straight axle type design. Front axles have non-adjustable (unbiased) camber, caster and knuckle pin inclination angles.

This section will address the general and specific maintenance requirements for the front axle's steering related components. Additionally, the front end alignment specifications and procedures will be discussed. Refer to the other applicable sections of this maintenance manual for further information on brake assemblies, hubs and other wheel end components.

COMPONENTS

The front axle assemblies are complete with steering arm and tie rod assembly, brake assembly, hub and drums and wheel end bearing and seal components. Axle knuckles vary slightly with disc and ABS type brake assemblies (Figure 1).

CENTER TUBE

The axle's center section is a square seamless steel tube. The center section is welded to the forged steel knuckle ends and tempered before final machining is performed.

WARNING

Do not attempt straightening of the axle. Any manipulation of or alteration to the axle could severely affect load rating and driveability.

TIE ROD ASSEMBLY

The tie rod assembly attaches to both knuckles via tie rod mounting arms, and maintains the correct axle steering geometry. The tie rod assembly has a non-adjustable center section and sealed replaceable ends.

KNUCKLE ENDS

Steering knuckles are attached to the axle ends with straight king pins and retained by a set of draw keys. Knuckles are fitted with special king pin bushings. King pin bushing covers, spacers and seals prevent dust and moisture from entering bushings. Stop screws installed on each knuckle assembly limit turning angle of the front wheels. Knuckles mount all steering and wheel end components (i.e., tie rod arms, drag ling steering arm, brakes, hubs, bearings).

NOTE: Balanced brake drums are provided on the front axle of the coach to reduce vibration and enhance ride characteristics. Machining (re-facing) of the balanced drums may require that they be rebalanced.

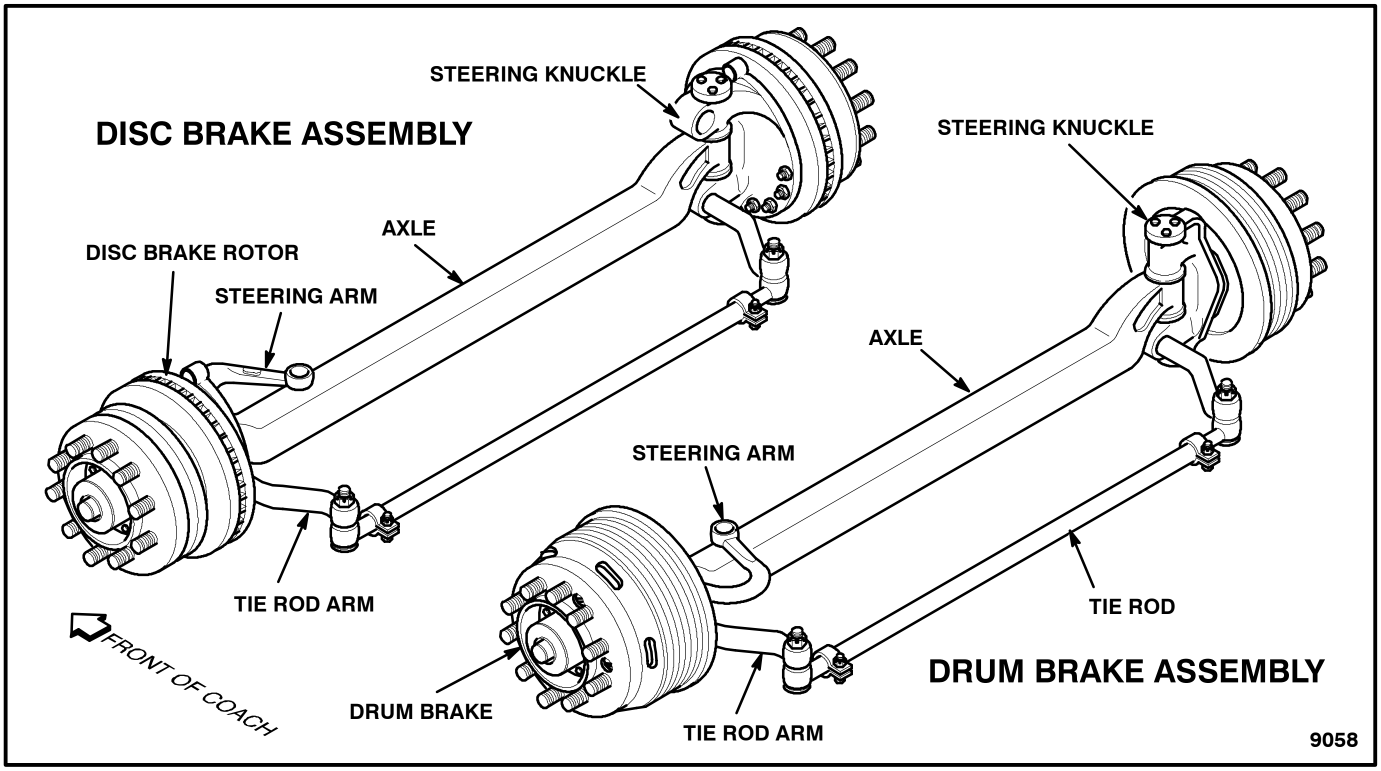

STEERING KNUCKLE
DISC BRAKE ASSEMBLY
STEERING KNUCKLE
AXLE
DISC BRAKE ROTOR
STEERING ARM
AXLE
STEERING ARM
TIE ROD ARM
TIE ROD
FRONT OF COACH
DRUM BRAKE ASSEMBLY
DRUM BRAKE
TIE ROD ARM
9058

Figure 1 Front Axle Assembly

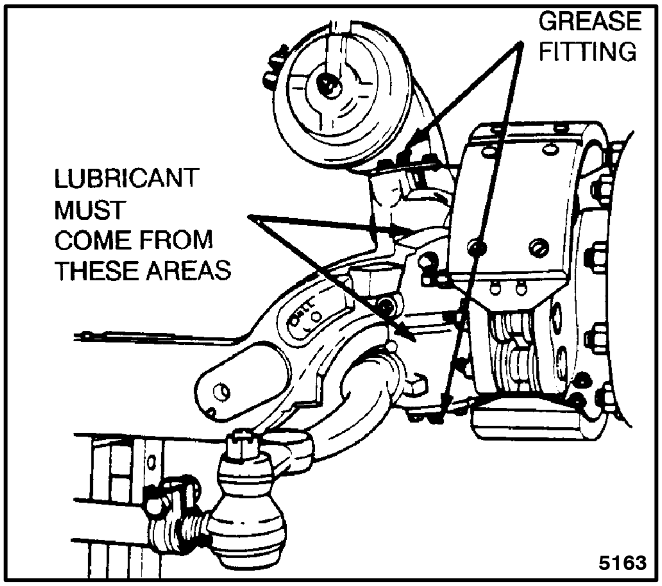

GREASE FITTING
LUBRICANT MUST COME FROM THESE AREAS
5163

Figure 2. Knuckle Pin Lubrication

LUBRICATION

Lubrication of the steering knuckle king pin bushings and tie rod ends is recommended at every 50,000 mile (80,000 km) interval. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL–MOBILITH AW-1).

NOTE: Some tie rod ends may have permanently lubricated ball studs that do not require lubrication. Inspect the boot seal every 96,000 miles (154,000 km) or every 12 months, whichever occurs first.

KNUCKLE PIN BUSHINGS

Steering knuckles are bushed in the upper and lower pin bosses so that they may turn freely about the pins. Bushings are grooved on the inside to allow grease to flow uniformly to high-pressure areas. Grease fittings are installed at both upper and lower knuckle pin bosses.

1. Raise the coach so that the tires are off the ground.
2. Lubricate the pins through the grease fittings on the top and bottom king pin covers (Figure 2).
3. Apply lubricant until new grease comes from the area between the seal of the thrust bearing and the upper shim pack.

TIE ROD ENDS

The tie rod ends have a grease fitting located on the inside rear of tie rod assembly.

1. Make certain the tires are touching the ground.
2. Apply grease through the grease fittings on the assembly (Figure 3).
3. Apply lubricant until new lubricant comes from the boot.

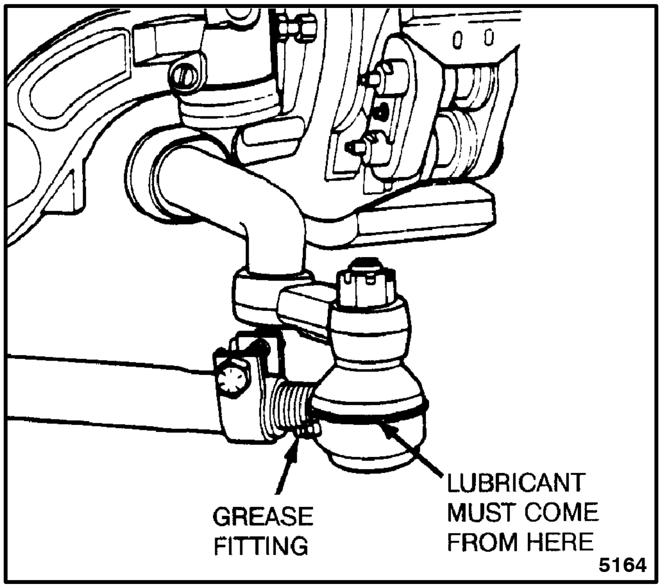


Figure 3. Cross Tube Lubrication

MAINTENANCE

ALIGNMENT

Correct front end alignment must be maintained for ease of steering and satisfactory tire life. Road shock, vibrations and normal stresses that are set up in the front end under average operation can result in loss of front end alignment. Refer to the following alignment data and specifications for correct adjustments (Figure 4).

NOTE: If incorrect front end alignment is suspected, refer to the inspection procedure under "Wheel Shimmy" later in this section. Front wheel balance should first be checked to make sure that the difficulties are not originating from out-of-balance front wheels or tires. Wheel installation and runout, wheel bearing adjustment, tie rod and draglink end wear should also be considered. Correct front end alignment can be obtained and maintained only when steering knuckles are in satisfactory condition. Factors in front end alignment are as follows:

FRONT WHEEL CAMBER: The amount the wheel leans outward "Positive Camber" or inward "Negative Camber" from the vertical plane, usually measured in degrees. All coach axles have "Unbiased" or equal camber.

NOTE: Axles are 1/4 degree "Positive Camber" in the unloaded condition, but may exhibit "Negative Camber" in some loaded conditions.

FRONT WHEEL TOE-IN: The distance the wheels are closer together at the front than at the rear.

AXLE CASTER: The fore and aft inclination from vertical of the steering knuckle. "Positive Caster" is indicated with the top of the steering knuckle towards the rear of the vehicle. "Negative Caster" is indicated with the top of the steering knuckle towards the front of the vehicle. "Zero Caster" means no inclination of the steering knuckle. All axles used on coaches should have non-adjustable positive caster.

KNUCKLE PIN INCLINATION: The amount knuckle pins are inclined inward at the top. Knuckle pin inclination is non-adjustable.

STEERING GEOMETRY: The specific location and/or movement of the mechanical links that maintain correct wheel alignment in relationship to the axle.

NOTE: All axles used on coaches have non-adjustable camber, caster and knuckle pin inclination angles.

⚠ WARNING ⚠

Any manipulation of or alteration to these axle characteristics could severely affect the axle's steering geometry.

NOTE: Camber, caster and toe-in settings can be found under "Alignment Data" in the specifications at the end of this section.

Checking Camber

Camber variations may be caused by wear at wheel bearings and steering knuckle bushings or by bent knuckle or sagging axle center.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is also affected by any deviation from specified camber.

Position front wheels on turning plates in a straight ahead position. Attach alignment gauges to each wheel spindle. Record the camber readings for each wheel and compare with specifications at the end of this section.

Adjusting Toe-In

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result. The following steps are to check and adjust toe-in:

NOTE: Make sure vehicle is on a level floor.

Do not measure toe-in with the front axle jacked up. The toe-in should be measured with the weight of the vehicle on the axle.

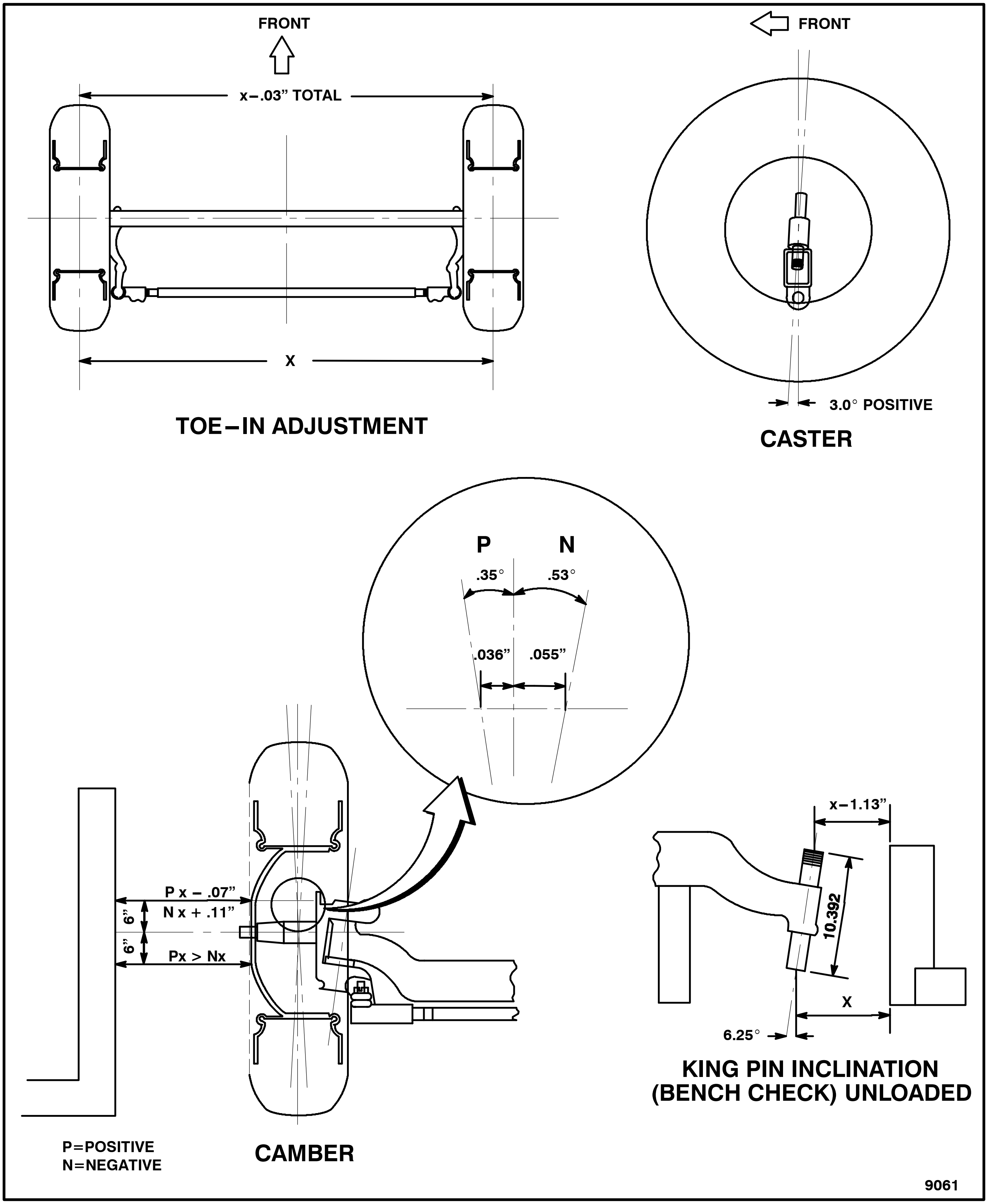

FRONT
x−.03" TOTAL
X
TOE−IN ADJUSTMENT
FRONT
3.0° POSITIVE
CASTER
P
N
.35°
.53°
.036"
.055"
P x − .07"
N x + .11"
6"
6"
Px > Nx
P=POSITIVE
N=NEGATIVE
CAMBER
x−1.13"
10.392
X
6.25°
KING PIN INCLINATION
(BENCH CHECK) UNLOADED
9061

Figure 4. Alignment Chart

1. Turn main battery disconnect to off. Jack up, level and block the front axle.

2. Use paint or chalk to contrast (white-out) the center area of both front tires around the entire circumference.

3. Position a scribe or pointed instrument mounted on a steady fixture, against the contrast area of each tire and rotate the tires to scribe a base line reference mark.

4. Place a full-floating turning radius gauge plate under each wheel. Lower the vehicle and remove the lock pins from the gauge plates. If full-floating gauge plates are not available, lower the vehicle and move it backward and then forward approximately 6 feet (1.8m).

5. Position trammel bar at rear of tires and adjust pointer to line up with scribed reference lines and lock in place (scale should be set on zero). Pointers must be raised to spindle height on the tire (Figure 5).

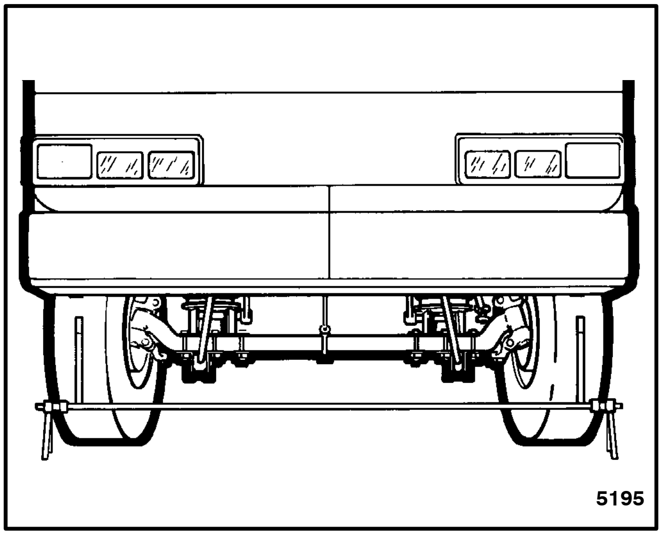


Figure 5. Trammel Bar With Pointers Set At Spindle Height

6. Position the trammel bar at the front of the tires. Adjust the scale end so that the pointers line up with the scribe marks.

7. Read toe-in or toe-out from the scale. Toe-in should read 0.03±0.03 inches (0.76±0.76 mm).

8. If adjustment is necessary, loosen the tie rod clamps and turn the tie rod as required, then re-tighten the clamps. If the vehicle is not on gauge plates, move it backward, then forward about 6 feet (1.8 meters).

9. Recheck the toe-in to ensure that it is correct.

Wheel Shimmy

For a variety of reasons a coach may develop a wheel shimmy at the front end. The following inspection procedure is provided to help assist maintenance personnel in determining the cause of this condition.

NOTE: Due to the large number of variables involved and the equipment needed to diagnose these variables, it is recommended that a reputable front end alignment shop perform the inspection and any corrections.

Read and understand all steps prior to starting step one. Observe all standard and applicable safety standards.

1. Check that all bolts and nuts are tight (i.e., suspension support stud nuts, U-bolt nuts, tie rod arm and steering arm nuts, etc.) and that no damage or distortion has taken place.

2. Check the steering gear for looseness and gear backlash.

3. Check the wheel balance or tires for out-of-round.

4. Check the hub and front drums for balance.

5. Check the tie rod ends for wear.

6. Check the radius rod bushings for wear.

7. Check for correct toe-in adjustment.

8. Check the knuckle pin end play or king pin bushings for wear. If the bushings have 0.010 inches or more of play, they should be replaced.

9. Check for correct caster.

NOTE: Excessive caster, in combination with some of the previous items, and/or in combination with road conditions, can cause wheel shimmy. A recommended 3.0 degree caster angle is achieved with the lower radius rod mounting brackets. The brackets have eyes in line with the axle center (Figure 6). caster angle is less than 2.0 degrees or more than 4.0 degrees contact customer service for further instructions.

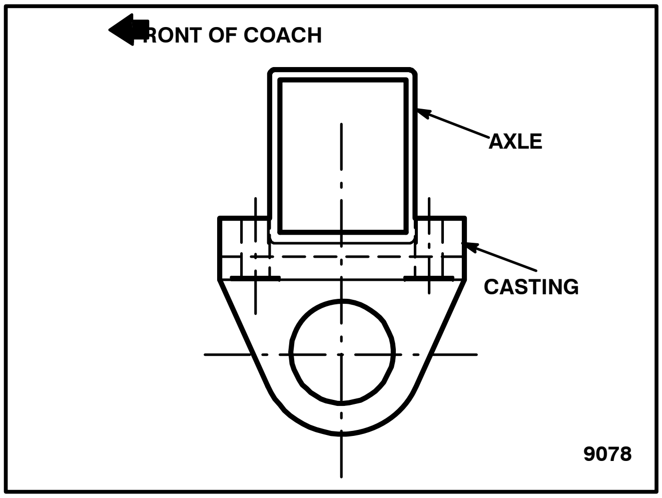


Figure 6. Center Mounting Radius Rod Bracket

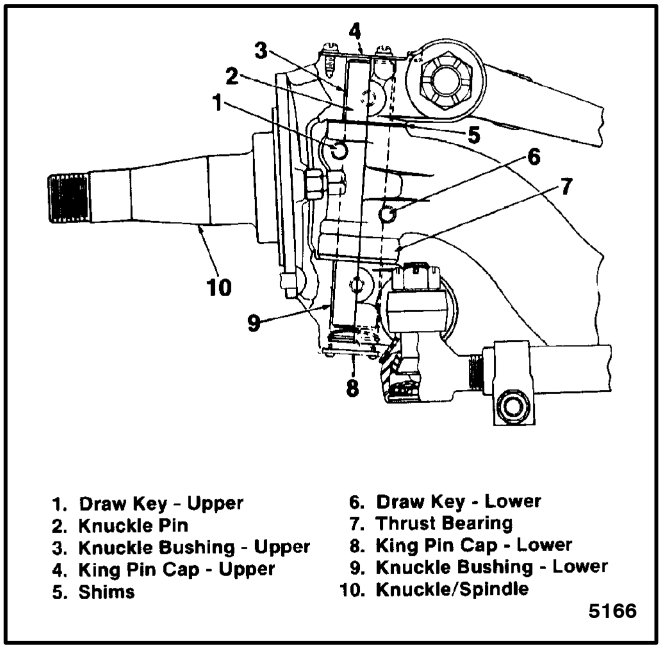

1
2
3
4
5
6
7
8
9
10
1. Draw Key - Upper
2. Knuckle Pin
3. Knuckle Bushing - Upper
4. King Pin Cap - Upper
5. Shims
6. Draw Key - Lower
7. Thrust Bearing
8. King Pin Cap - Lower
9. Knuckle Bushing - Lower
10. Knuckle/Spindle
5166

Figure 7. Steering Knuckle

STEERING KNUCKLE

Steering knuckles, knuckle pins, and bushings may be serviced or replaced without removing the axle from the coach. The axle to steering knuckle pivot joint utilizes straight knuckle king pins. Typical steering knuckle components are shown below (Figure 7).

Inspection

A loose steering linkage under normal steering loads is sufficient cause to immediately check all pivot points for wear. Special attention should also be given to the condition of the steering knuckle king pins and bushings. The axle manufacturer recommends that the “Easy Steer” knuckle pin bushings be replaced when the range of side-to-side tire movement reaches 0.30-inch, or when the bushings are worn to a maximum of 0.01-inch on their diameter (Figure 8). With new bushings installed, the range of side-to-side tire movement should not exceed 0.01 inch maximum.

NOTE: These measurements are made with the wheel bearings correctly adjusted on the spindle.

Removal

1. Block the rear wheels to prevent the vehicle from rolling. Jack up front of coach so that tires clear floor. Block up securely at this position and remove jacks.

WARNING

Do not attempt to remove steering knuckle while coach is supported by jacks only.

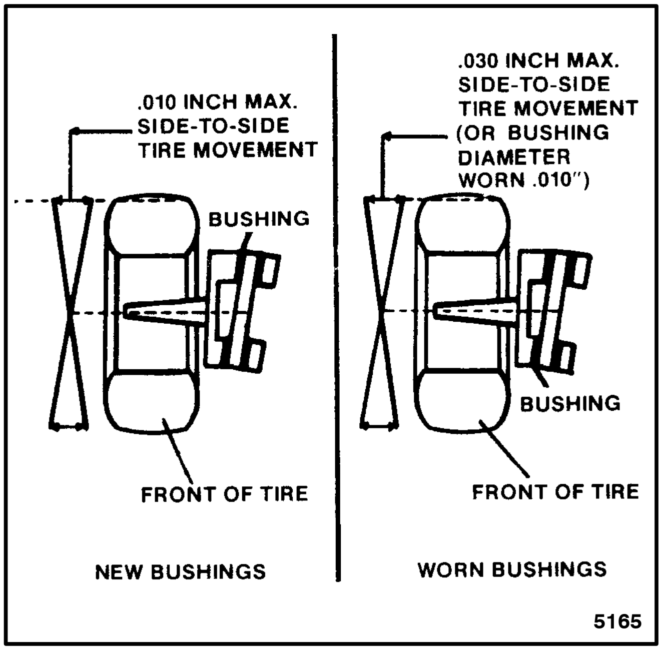

.010 INCH MAX.
SIDE-TO-SIDE
TIRE MOVEMENT
BUSHING
FRONT OF TIRE
NEW BUSHINGS
.030 INCH MAX.
SIDE-TO-SIDE
TIRE MOVEMENT
(OR BUSHING
DIAMETER
WORN .010")
BUSHING
FRONT OF TIRE
WORN BUSHINGS
5165

Figure 8. Side-To-Side Tire Movements With New and Worn Knuckle Pin Bushings

2. Remove front wheels, hubs and bearings as directed in Section 15.

3. Remove brake chambers and brake shoe hardware from steering knuckle. Detach brake shoe spider from knuckle and remove spider, camshaft and slack adjuster as an assembly.

4. Remove drag link and tie rod from steering arm. Refer to Steering, Section 11.

5. Remove nuts from steering arms and drive arms out of steering knuckles.

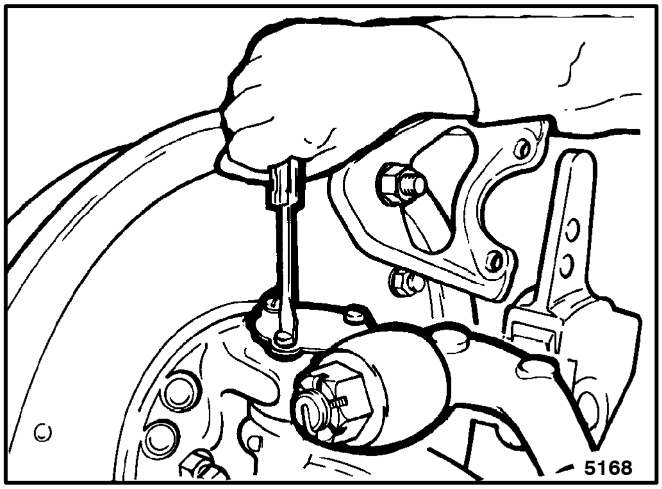


Figure 9. Removing Knuckle Pin Cover

NOTE: It is not necessary to remove steering arms unless service or inspection is necessary.

6. Remove the capscrews from the knuckle pin covers and the gaskets beneath the cover (Figure 9).

NOTE: The inspection and/or measurement for “Knuckle End Play” may be performed at this time.

7. Unfasten draw key locknuts and turn out to the end of the threads.

8. Firmly strike the end of the nut with a brass drift and a hammer to loosen. Remove the nut and key from the axle center.

NOTE: The straight style knuckle king pins are retained by means of threaded draw keys at the top and bottom of the knuckle. Failure to strike the draw key squarely with a brass drift may result in a damaged key. The knuckle king pin is removed from the knuckle by also using a bronze drift (Figure 10).

⚠ WARNING ⚠

Do not strike the knuckle pin directly with a steel hammer. The pins are made of hardened steel. Personal injury can result from flying chips and splinters and, in the case of the tapered style pin, the threads on the upper end will be damaged.

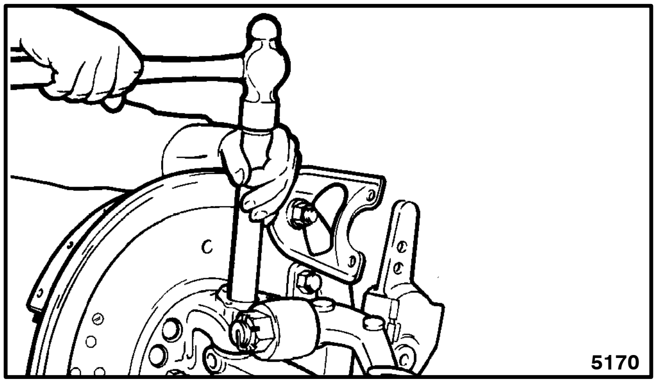


Figure 10. Removal of Knuckle Pin

9. Gently tap the king pin out of the steering knuckle. Straight type knuckle king pins may be removed through either the top or bottom of the knuckle.

NOTE: If the bushings are not to be replaced, precautions must be taken not to damage them with the bronze drift. Grind off any flaring on the end of the drift which will contact the pin. Wrap tape around the drift 1/16 inch thick for the first inch from the end of the drift. This is especially important when the bushings are of the “Easy Steer” type used with the straight type knuckle pin.

10. Lift the knuckle assembly, thrust bearing and shims off the axle end (Figure 11).

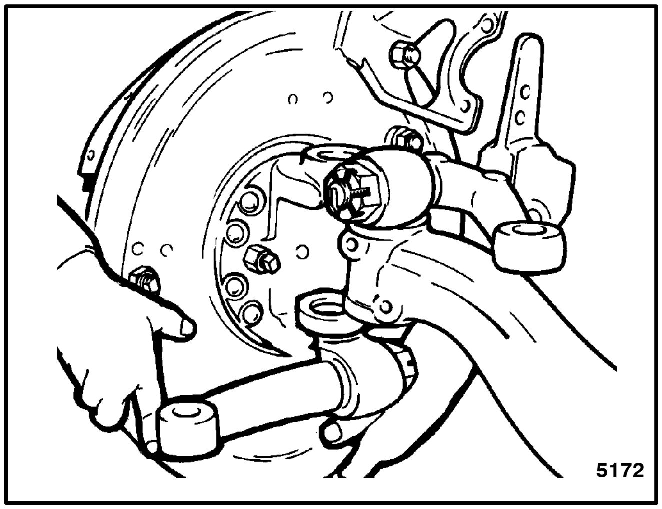


Figure 11. Removing Steering Knuckle

Bushing Replacement

Specialized tools are required for bushing replacement. Tool 20-5 should be used when removing or replacing the bushings. Tool 20-312 should be used to size the bushings after placement. A press of at least 5-ton capacity is required to remove or install the bushings in the steering knuckles.

NOTE: Tools can be made from round steel bar stock, are purchased locally.

⚠ WARNING ⚠

Before beginning the removal or installation of the bushings, always assure that the steering knuckle is fixed firmly on the bed of the press to avoid slippage.

Removal

1. Insert the tool’s pilot end into the bore of the top bushing and press it into the center of knuckle to be removed.

2. Turn knuckle over in press and lock down firmly. Repeat step 1 for bottom bushing.

Installation

1. Insert the tool’s pilot end into the bore of the bushing, and press the top bushing 1/8 inch into the knuckle.

2. Check alignment of tool and bushing before pressing to the desired depth of 0.477 - 0.507-inch from the top of the machined surface.

3. Turn knuckle over in press and lock down firmly. Repeat steps 1 & 2 pressing the lower bushing in to a depth of 0.412 - 0.442-inch in from the bottom machined surface, similar to Figure 15.

NOTE: Proper grease seal clearance is required at both top and bottom bushing's inner edge (Figure 15). Do not install the seals until all bushing reaming procedures are completed.

4. Using reamer 20-312, finish the bushings to 1.7950 – 1.7960-inch diameter using the "Bushing Reaming" procedure that follows.

Bushing Reaming

There are several methods of sizing new bushings but the only method which will give accurate size and alignment of the bore is reaming. The bushings must also be in line with each other to within 0.001-inch. Honing and burnishing do not provide good, bushing bore alignment. Easy steer bushings are made of too resilient a material for them to be sized with a burnishing ball or bar. The recommended procedure for reaming the bushings is as follows:

1. Position the knuckle in a vise with knuckle pin holes in the vertical.
2. Gently slide the reamer pilot through the upper bushing until the reamer cutters begin to engage the upper bushing (Figure 12).
3. Begin rotating the reamer and applying a light downward pressure with your hand at the same time.

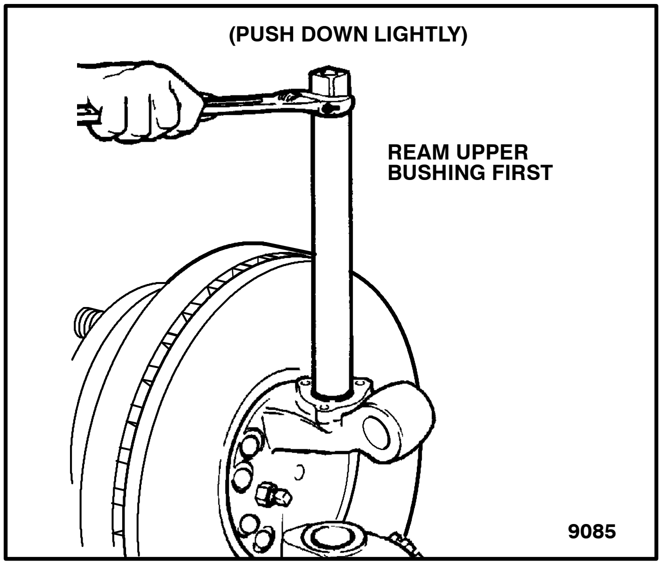


Figure 12. Sizing Upper Bushing

NOTE: Do not force the reamer by applying too much downward force. The reamer can be rotated at any speed but should be done smoothly.

4. After the reamer sizes most of the upper bushing, support the reamer so that it does not drop to the bottom bushing as it completes the cut.

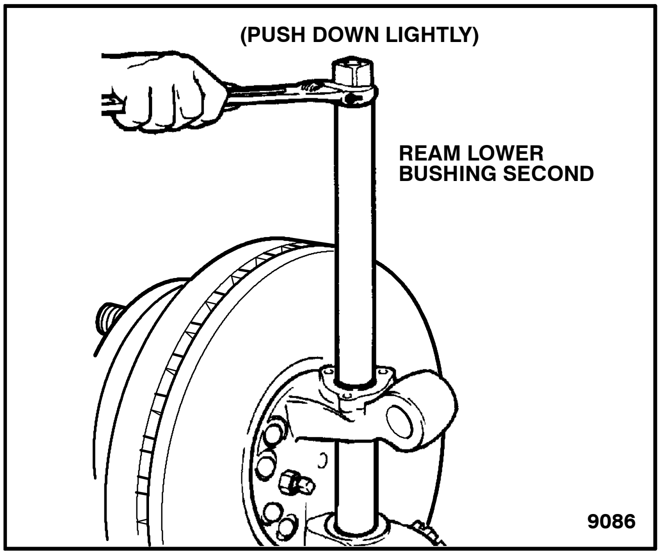


Figure 13. Sizing Lower Bushing

5. After the upper bushing has been sized, gently slide the reamer through until it engages the bottom bushing (Figure 13). Repeat steps 3 and 4 for the bottom bushing.
6. Slide the reamer out through the bottom. If the reamer must be pulled back up through the bushing, do so only while rotating the reamer in reverse. Any other way will damage the bushings.
7. Clean bushing debris from bores before installing seals.

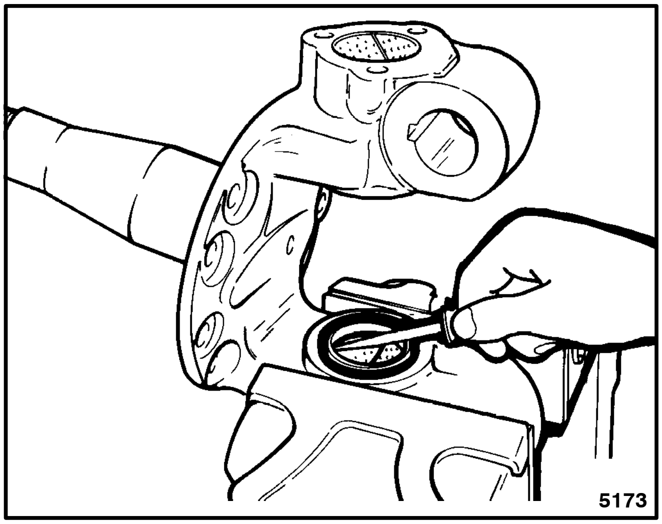


Figure 14. Grease Seal Removal

Seal Replacement

Removal

1. Place steering knuckle in vise, and pry out seals with awe or a screwdriver (Figure 14).

Installation

1. Place steering knuckle in a vise with knuckle pin boss holes in the vertical.

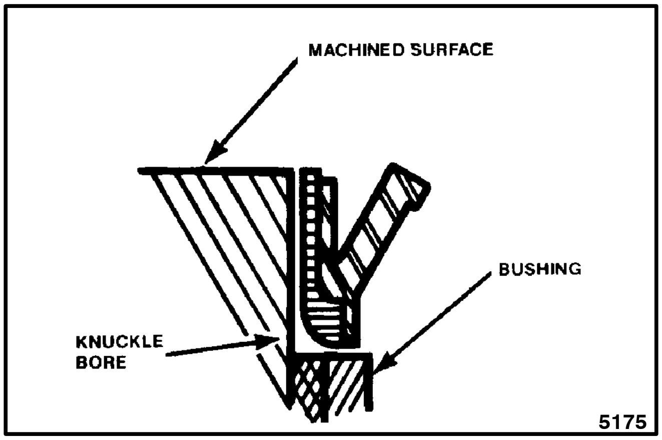


Figure 15. Grease Seal Installed in Knuckle

2. With the knuckle pin boss held firmly in this position, place the seal over the lower counterbore.

> **NOTE:** Grease seals must be installed with rubber lip facing up to allow grease purge (Figure 15).

3. Using a suitable sleeve and a bronze drift, tap the seal into the knuckle bore until it is flush with the machined surface (Figure 16).

4. Turn knuckle over in the vise, and repeat steps 2 & 3 to install the other seal.

> **NOTE:** Do not use a hammer to install seal. Set the seal in the opening and cover it with a rigid flat metal plate or use old seal. Tap the plate with a hammer directly over the seal until the seal is flush with the machined surface.

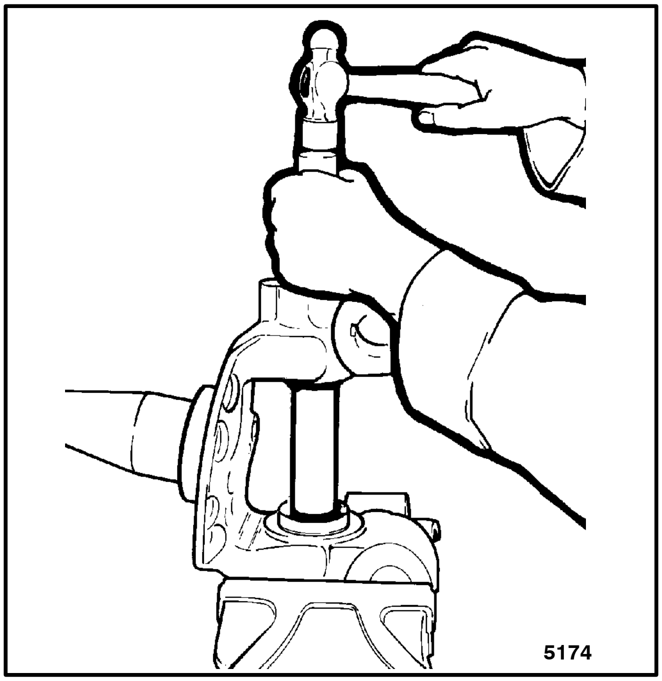


Figure 16. Installation of Grease Seal

Installation

1. Assemble the thrust bearing and seal assembly in preparation of installation.

> **NOTE:** Assemble the bearing and seal by holding the bearing so that the opening between the bearing cage and the retainer is up (Figure 17). Snap seal securely over the top. Some thrust bearings may have the word “TOP” stamped on the flat face of the bearing retainer. Disregard this marking for bearing installation purposes.

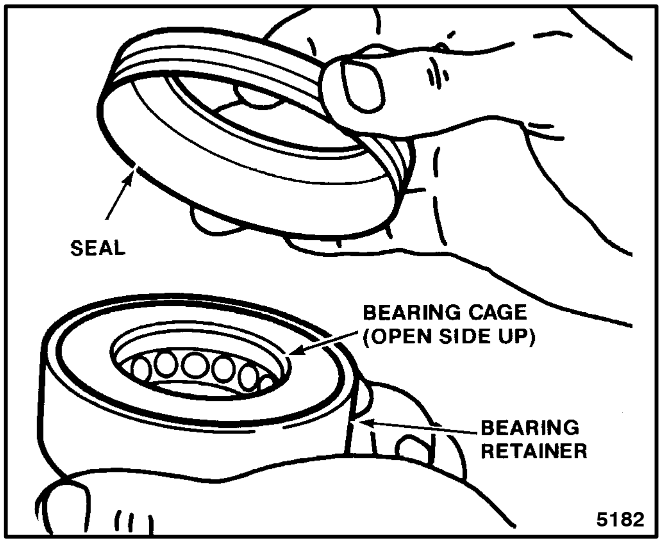


Figure 17. Bearing And Seal Assembly

2. Position and support the steering knuckle on the axle end.

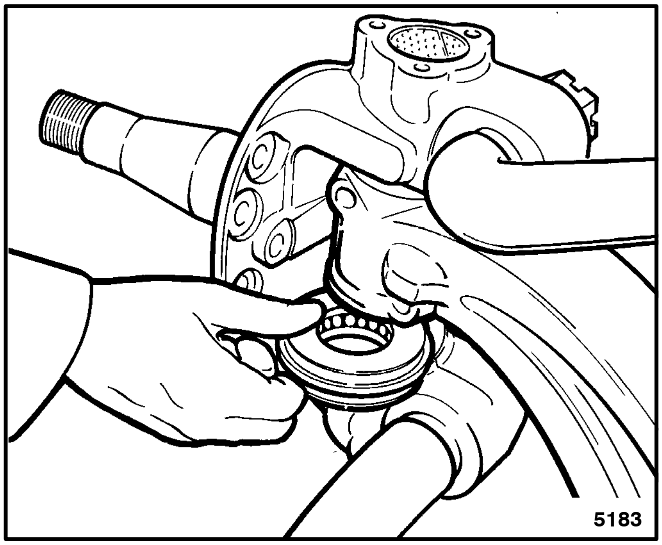


Figure 18. Knuckle & Seal Installation

3. With thrust bearing positioned so seal is facing up, slide the bearing and seal assembly between the lower face of the axle end and the upper face of the lower knuckle yoke (Figure 18).

NOTE: Shimming of the knuckle to the axle assembly may be required. Refer to "Knuckle End Play" inspection procedures that follows to determine if shimming is necessary. Shims are positioned between the upper knuckle yoke and axle end boss (Figure 19).

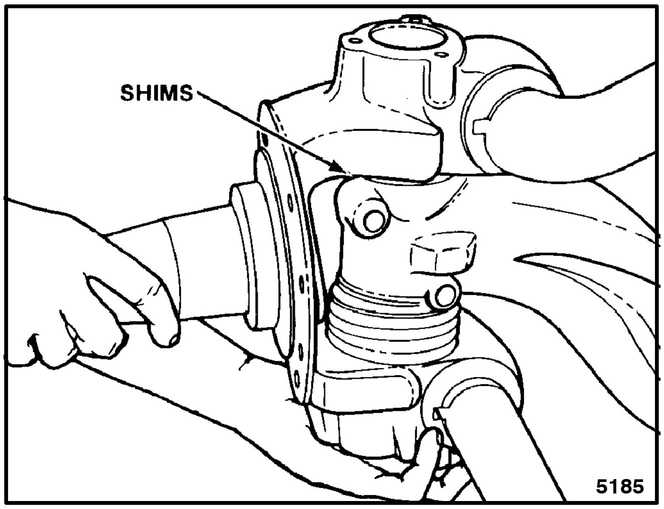


Figure 19. Shimming Axle And Knuckle

4. Alignment of the knuckle boss king pin holes to the axle end boss is now required for knuckle king pin installation.

NOTE: While looking down through the knuckle pin hole, shift the knuckle to align it with the axle end. Now align the shims to be flush with the axle end around the entire circumference of the knuckle king pin hole. The shim alignment can be done through the upper bushing. Any protrusion of any portion of the shim will prevent the knuckle pin from passing through and result in a damaged shim.

⚠ CAUTION ⚠

Shims are delicate and sharp. Extreme caution should be exercised while aligning shims so as not to cut fingers or bend the inside diameter of the shims. Damage to the shims during this entire procedure requires disassembly and replacement of the damaged parts.

5. Smear clean chassis grease on the bottom half of the knuckle pin and insert it slowly into the top of the knuckle.

NOTE: Knuckle pins are marked with the Rockwell logo, part number and the word "top" on the top end of the pin.

6. Rotate the pin to align the draw key slots with the draw key holes in the axle. Slowly push the pin through the bushing, seal and shim pack. After the pin is inserted through the shim pack, a brass hammer may be used to further assist in installation.

NOTE: The pin should slide through the shim pack freely. Any resistance greater than a hand push indicates misalignment. Remove the pin and realign the components. Care must be taken not to dislodge the lower grease seal as the knuckle pin enters the lower knuckle yoke.

7. Center the knuckle king pin in the knuckle equal distance from the outer top and bottom surfaces.

8. Lightly tap the draw keys into position, flat side toward the knuckle pin; do not firmly seat them until after the end play measurement.

NOTE: Never install both draw keys from the same side. Install the lower draw key from the front side and the upper draw key from the rear. Assemble so the wedged ends of the two keys contact the knuckle pin and torque to restrict pin from moving while the end play is measured. Perform "Knuckle End Play" measurements at this time per procedure that follows.

9. After shimming has been completed, seat the draw keys firmly with a hammer and drift (Figure 20).

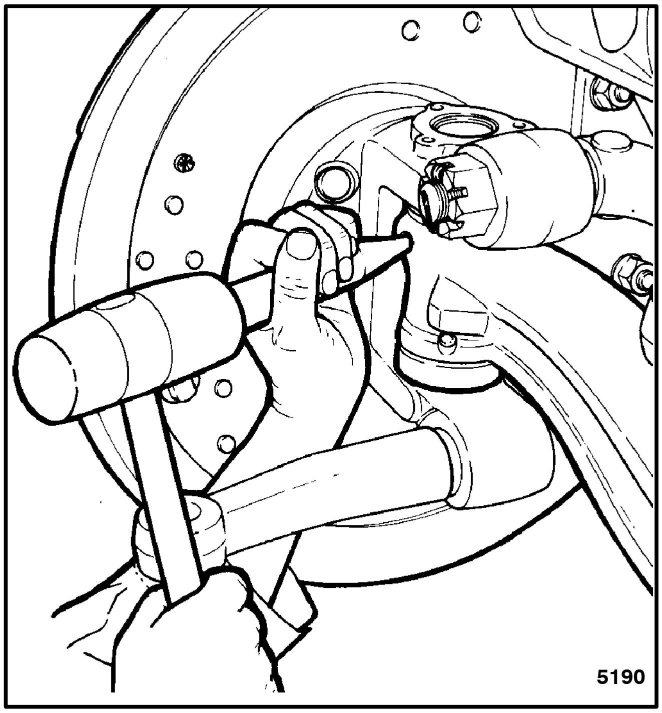


Figure 20. Seating Draw Keys

NOTE: Even though they are threaded, the keys must be solidly seated in this manner. The nut torque on the threaded design is only sufficient to hold the key in position and is not adequate to properly seat the key.

10. Install flanged locknut and torque to 30-40 ft-lbs (41-54 N·m).

⚠ CAUTION ⚠

Before knuckle king pin caps are installed, recheck draw keys by rotating the knuckles to be sure the final staking or torquing procedure has secured them. Omission of the final king pin securing steps may result in damaged or broken knuckle boss, king pins and axle ends.

11. Install king pin caps and gaskets and torque cap fasteners to 20-30 ft-lbs (27-41 N·m)

NOTE: Caps require orienting the flat side toward the gasket. The flat side contains no numbering or lettering.

12. Lubricate the upper bushing first, then the lower bushing.

NOTE: If grease does not flow through the thrust bearing, it will be necessary to raise the knuckle with a jack to close off passage of grease around the thrust bearing.

13. Rotate knuckle lock to lock to help distribute the grease, and relubricate.

14. Fill any voids in the draw key holes with grease to prevent corrosion and ease future disassembly.

Knuckle End Play

Shims are used to limit the vertical movement of the knuckle with respect to the axle center and knuckle pin. Some clearance in this area is required, however, to allow grease to purge from the upper bushing area. Carefully inspect shims, new or used, to be sure none are kinked, bent or torn. Discard any that are damaged. Select a quantity of shims to obtain as little vertical end play as possible. Lift the knuckle in position and slide the shim pack between the axle end boss and the knuckle upper yoke.

Knuckle end play can be measured without hubs, brake spiders, wheels and tires during rebuild as outlined in the first procedure, or with the axle in service as in the second procedure.

NOTE: The use of shim gauges (feeler gauges) for measurement of clearance tolerances on steering knuckles is not recommended. These will not give an accurate reading of end play. Use only a dial indicator. End play is the free movement of the steering knuckle up and down along the axis of the knuckle pin. Some end play is required to prevent binding of the knuckle while turning and to provide a passage for grease to purge during bushing lubrication. Excessive end play can cause interference between the knuckle pin and end caps or retainers.

Procedure 1

1. With knuckle pin caps off, turn the knuckle to the straight ahead position. Take a rubber mallet and repeatedly strike the top pin boss of the knuckle (Figure 21). This will shift all of the components down and remove grease layers so an accurate reading may be taken.

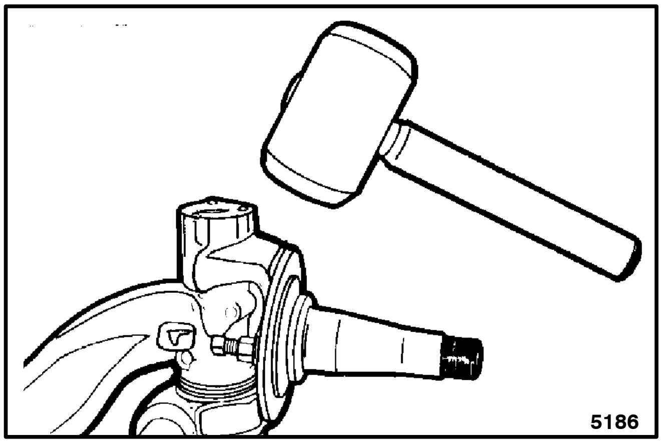


Figure 21. Loosen Knuckle

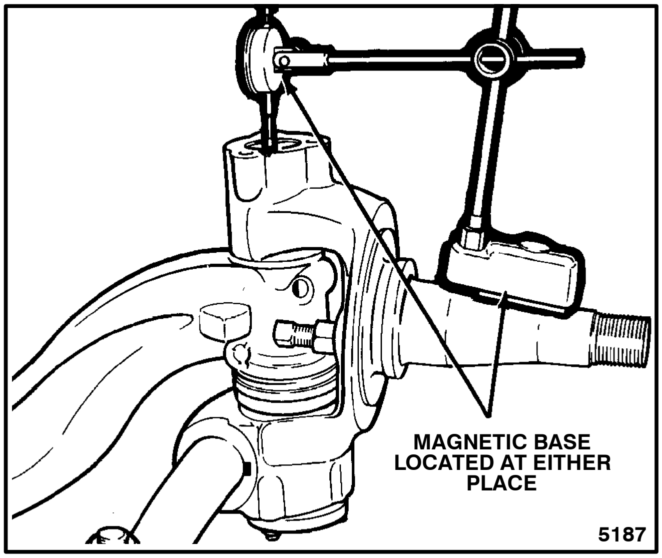


Figure 22. Dial Indicator Installation

NOTE: Attach the dial indicator with a "C" clamp or magnetic base to the knuckle spindle such that the knuckle can be turned freely.

2. Place the dial indicator plunger on the exposed end of the knuckle pin so that its line of action is approximately parallel to the knuckle pin center line, and zero the dial indicator (Figure 22).

3. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement (Figure 23).

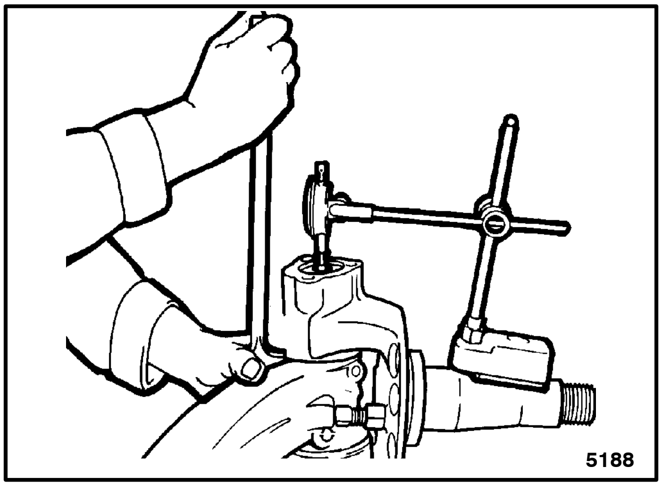


Figure 23. Measuring End Play

NOTE: A small hydraulic jack under a block of wood can be used beneath the knuckle to provide the necessary lift (Figure 24). Keep lifting the knuckle until the dial indicator reading levels off.

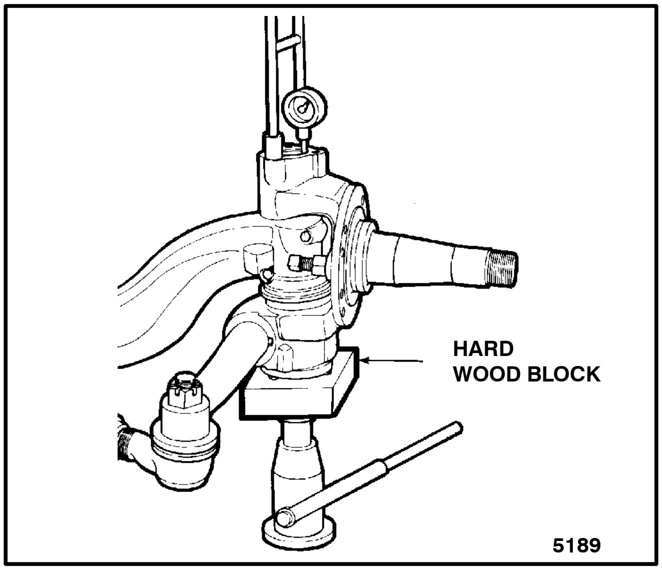


Figure 24. Jacking Knuckle

⚠ WARNING ⚠

When using a hydraulic jack, be sure that the axle is supported by two jack stands. Raising the end in this manner may cause an axle supported only in the center to tip and fall, causing personal injury.

4. Repeat steps 1 thru 4 with the knuckle in the full right and left turn positions. This is necessary to be sure that no binding or excessive play is present during turns.

NOTE: If binding exists or zero end play is measured anywhere in the full travel of the knuckle, remove shims as required to obtain end play of 0.001-0.025-inch. After measuring knuckle clearance (end play) of over 0.025-inch, add shims between upper knuckle pin boss and axle center end, as required, to obtain an end play of 0.001-0.025-inch (0.02-0.64 mm) through full range of turn. Normal seating of the bearing, seal and shims will increase the end play reading after a short time in service.

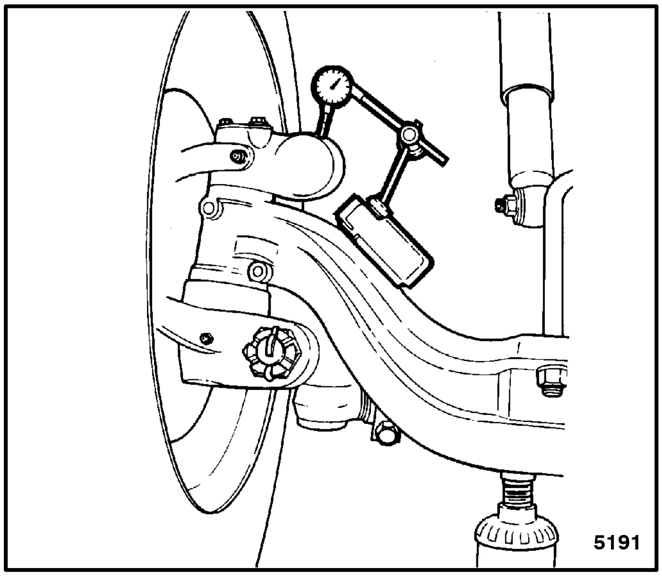


Figure 25. Dial Indicator Positioned

Procedure 2

1. Securely block vehicle to prevent rolling.

2. Place a jack under the axle beam as close as possible to the knuckle end being checked and jack the vehicle up until the tire is clear of the floor.

NOTE: Attach a dial indicator to the axle beam with a "C" clamp or magnetic base.

3. Place the dial indicator plunger on top of the knuckle pin cap or knuckle forging so than its line of action is approximately parallel to the knuckle pin center line, and zero the dial indicator (Figure 25).

4. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement.

⚠ WARNING ⚠

In service axle end play may increase to a maximum of 0.065-inch (1.70 mm) at which time it will be necessary to re-shim end play back to 0.001 - 0.025-inch (0.02 - 0.64 mm).

NOTE: If a reading of over 0.065-inch is taken, remove the tire and knuckle pin cap and remeasure as in first procedure. If the reading is still over 0.065-inch, shimming of the knuckle to specifications is required.

TIE ROD ASSEMBLY

The tie rod assembly connects the two axle knuckles together. It is constructed of a center cross tube and two non-repairable end assemblies (Figure 26). The rod is threaded on each end as are the rod ends which are held on additionally by clamps.

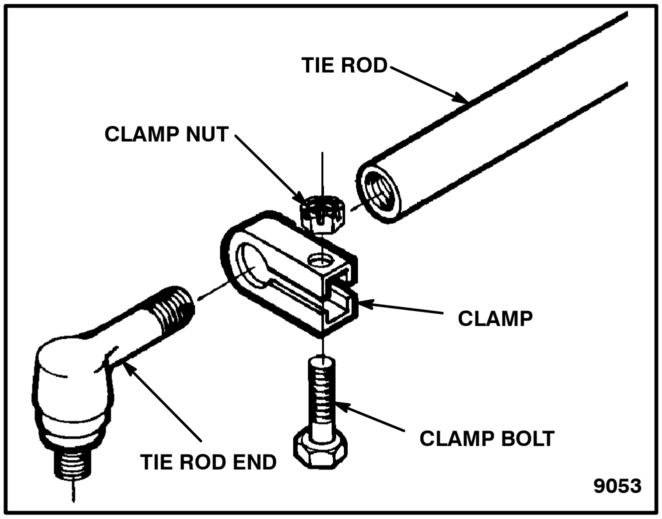


Figure 26. Tie Rod Assembly

Steering linkage pivot points should be checked each time the axle assembly is lubricated. If any indication of lateral movement is found, cross tube ends should be removed for inspection. Loose steering linkage pivot points can be visually detected during movement of the vehicle steering wheel. Socket wear in the tie rod end assembly is indicated by ball stud turning torque and socket end movement.

NOTE: To check the turning torque value between the tie rod end assembly stud and the ball cavity, the socket must be removed from the vehicle. Minimum allowable torque value is 5 in-lbs (0.565 N·m).

Movement may be checked with end attached to its mating arm. New socket assemblies should have an end movement of not more than 0.020 inches (0.508 mm). Maximum allowable end movement on worn sockets is 0.090 inches (2.28 mm).

End Replacement

1. Remove cotter pin and unfasten nut attaching end to the tie rod arm.

2. Using a small drift, rap the side of the tie rod end to loosen, and remove from tie rod arm.

3. Loosen clamp bolts and unthread tie rod ends from the cross tube.

4. Thread new tie rod end into the cross tube, until the tie rod end's tapered stud will slip into the tie rod arm.

5. Tighten clamp bolts to 55-60 ft-lbs torque (75-88 N·m).

6. Attach and tighten tie rod end-to-arm hex nut to 165-180 ft-lbs torque (224-244 N·m), and insert new cotter pin.

7. Lubricate new tie rod end, and check alignment.

AXLE ASSEMBLY

Periodically inspect all mounting fasteners to assure proper torques as shown in the specifications at the end of this and other sections (Figure 27). Inspections of the axle should also be made to check for damage, distortion or fatigue cracks.

NOTE: Magnetic particle (Magnaflux) examinations or dye penetrant inspections can be preformed to check for axle cracks.

⚠ WARNING ⚠

Any damaged axles or axles with cracks should be immediately removed from service and replaced.

Removal

If extensive maintenance of the front axle is necessary, the axle should, of course, be removed from the coach. To remove the entire front axle as an assembly follow this procedure:

1. Turn the main battery disconnect switch to off, and block the rear wheels to prevent the vehicle from rolling.

2. Raise the front end of the coach with jacks until the bottom of the coach body is approximately 18 inches (457.2 mm) from the floor. Block the body in this position as indicated in Section 3 under Coach Jacking Points.

⚠ CAUTION ⚠

Do not raise the body in such a way that the entire weight of the front axle will hang on the suspension bellows assemblies. Damage to the air springs may result.

⚠ WARNING ⚠

Do not attempt to repair, remove or reinstall front axle with the vehicle supported by jacks only.

3. Remove tires and wheels as detailed in Section 15.

4. Exhaust air pressure from the suspension air tank by opening drain tank at bottom of the air filter.

5. Disconnect the height control valve link, and pull down on the height control valve arm to exhaust air from the front air bellows.

6. Disconnect the hose from the front brake chambers.

7. Disconnect the steering drag link as shown in Section 11.

8. Disconnect both ends of all radius rods as outlined in Section 12B.

9. Unfasten and remove the sway bar as outlined in Section 12B. Unfasten and remove sway bar mounting brackets from axle if required.

10. Remove nuts from all bolts attaching air springs lower mounting to the axle tower.

11. Remove shock absorbers as outlined in Section 12.

12. Lower the axle assembly on jacks until air spring bead ring bolts are cleared of the suspension supports. The axle can now be carefully removed from under the vehicle.

Installation

Reinstall the axle assembly is the reverse of removal. Check front end alignment after installation.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Rapid or uneven tire wear.	A. Incorrect toe–in setting.	A. Check toe–in and reset as required. When setting toe–in, it is important to neutralize the component and tire deflections by backing up and then going forward and rechecking the toe–in. This is especially important with radial tires. The check and possible re–set should be followed even if bearing plates are used.
	B. Improper tire inflation.	B. Check tires for proper inflation.
	C. Unbalanced tires.	C. Check tire pressures.
2. Hard Steering	A. Low power steering system pressure.	A. Check power steering fluid level. Check power steering pump pressure.
	B. Improper assembly or adjustment of steering gear box.	B. Check steering gear box adjustments.
	C. Inadequate or improper lubrication of knuckle pins.	C. Lubricate knuckle pins and recheck steering.
	D. Improper Caster.	D. Check caster and set as required.
	E. Tight draglink or tie rod ends.	E. Check draglink and tie rod ends. Replace if they are too tight.
	F. Worn thrust bearing.	F. Check knuckle end play.
3. Rapid Wear of Cross Tube Ends	A. Inadequate or improper lubrication.	A. Check lubrication procedures and evaluate interval for possible revision. Check dust covers for tears.
	B. Severely contaminative environment.	B. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
	C. Failure of protective dust cover.	C. Inspect dust covers and replace ends where covers have failed
4. Bent or Broken Cross Tube, Broken Ball Stud, Bent or Broken Steering Arm or Cross Tube Arm	A. Excessive power steering system pressure.	A. Check system pressure. Reset pressure cut–off if required.
	B. Misadjusted power steering cut–off.	B. Check system pressure. Reset pressure cut–off if required.

TROUBLESHOOTING (CONTD.)

SYMPTOM	PROBABLE CAUSE	REMEDY
	C. Operational (curbing)	C. Check driving habits, refrain from impacting curbs.
5. Heavily Worn or Broken Steering Arm Ballstud	A. Overtighten draglink.	A. Replace and ensure proper torques are used.
	B. Inadequate or improper lubrication.	B. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
6. Excessive Wear of Knuckle Pins and Bushings	A. Worn or missing seals and gaskets.	A. Check and rebuild to proper specifications.
	B. Improper type of grease.	B. Check lubrication specifications against lube being used. Ensure use of proper lube.
	C. Inadequate lubrication frequency.	C. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
	D. Improper lubrication technique.	D. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
	E. Inadequate lubrication frequency due to extreme operating conditions such as abrasive dust and sandy environments.	E. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
7. Front Axle Shimmy or Vibration	A. Incorrect master setting.	A. Check alignment and correct as necessary.
	B. Wheels and/or tires not properly balanced.	B. Check tire balance and adjust as required.
	C. Worn shock absorbers.	C. Replace shocks.

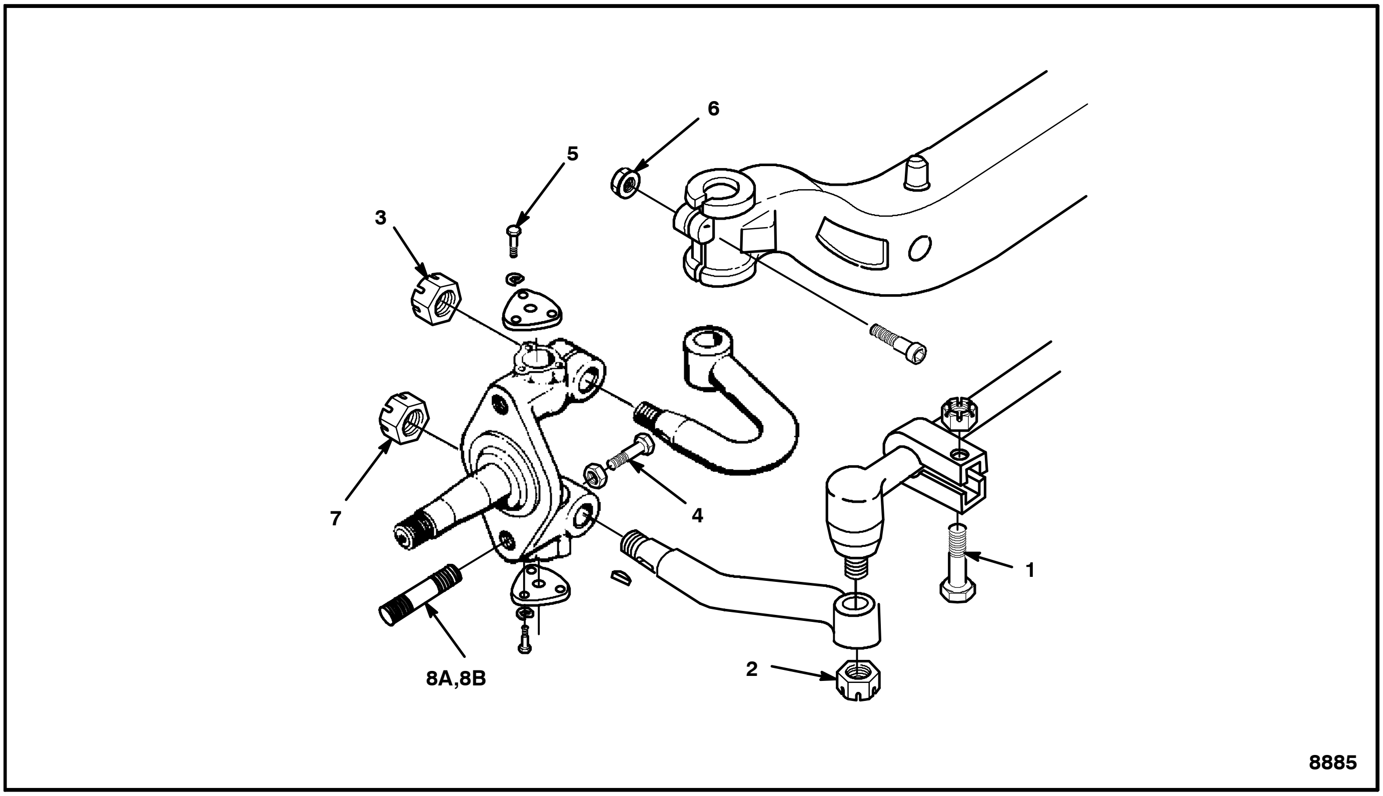


Figure 27. Front Axle Torques

TORQUE SPECIFICATIONS

1. Tie Rod End Clamp Bolt Nuts	40-60 ft-lbs (54-81 N·m)
2. Tie Rod Arm to Tie Rod End Stud Nuts	160-300 ft-lbs (216-406 N·m)
3. Steering Arm to Knuckle Nuts	775-1450 ft-lbs (1050-1966 N·m)
4. Stop Screw Locknut	50-65 ft-lbs (68-88 N·m)
5. King Pin Cap Capscrews	20-30 ft-lbs (28-40 N·m)
6. Draw Key Nut	30-45 ft-lbs (41-61 N·m)
7. Tie Rod Arm to Knuckle Nut	550-1025 ft-lbs (746-1389 N·m)
8A. Spider to Knuckle Stud Hex Nut or Capscrew (2-Bolt Pattern)	440-580 ft-lbs (596-786 N·m)
8B. Spider to Knuckle Capscrew (8-Bolt Pattern)	180-240 ft-lbs (244-325 N·m)

SPECIFICATIONS

AXLE CENTER

Manufacturer	Rockwell International
Part Number (Drum)	1K-1-26
Part Number (Disc)	1L-1-1
Design	(Reverse Elliot) Tubular
Allowable Twist (Variation Between Ends)	1/2 Degree

STEERING KNUCKLES

Spindle Diameter: Inner Bearing	2.625-2.624 in. (66.662-66.637 mm)
Spindle Diameter: Outer Bearing (Drum)	2.125-2.124 in. (53.962-53.936 mm)
Spindle Diameter: Outer Bearing (Disc)	1.750-1.749 in. (44.441-44.415 mm)
Up-And-Down Movement	0.005-0.065 in. (0.127-1.65 mm)
Bushing Bore Diameter	1.9019-1.921 in. (48.743-45.657 mm)

STEERING KNUCKLE BUSHINGS

Type	"Easy Steer"
Ream Diameter	1.796-1.795 in. (45.618-45.593 mm)
Type	Straight
Diameter	1.794-1.793 in. (45.568-45.542 mm)

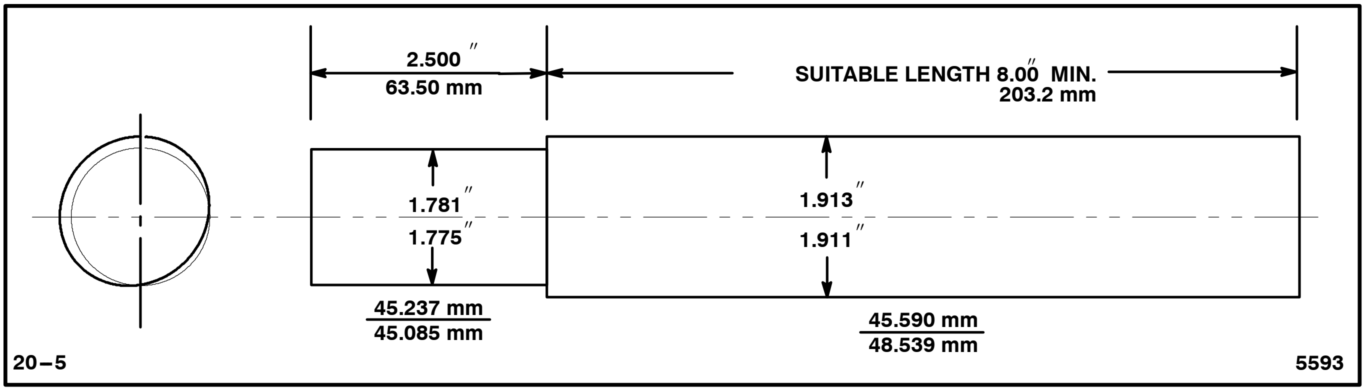
ALIGNMENT DATA (LOADED)*

Camber	(Acceptable Range) -.53-.35 Degree
Caster	3.0 Degrees (Positive)
Toe-In (Adjustable)	.0.03 in. Total (± .03 inches) (0.76±0.76 mm)
Track:	85.6" (2.17 m)

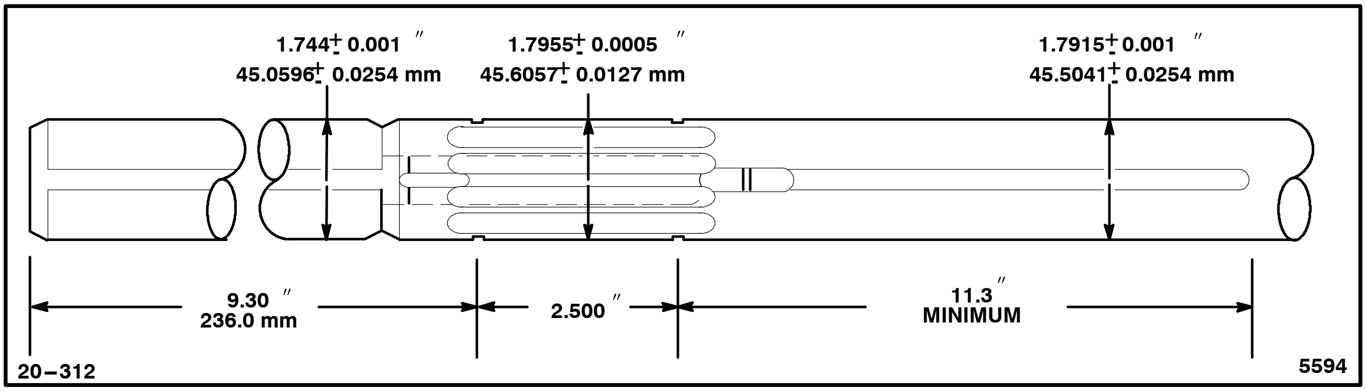
* Note: Based on empty coach front axle weight of 10,000 lbs.

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.


2.500 ″
63.50 mm
SUITABLE LENGTH 8.00″ MIN.
203.2 mm
1.781″
1.775″
1.913″
1.911″
45.237 mm
45.085 mm
45.590 mm
48.539 mm
20−5
5593

20-5 Tool - King Pin Bushing Removal & Installation


1.744± 0.001 ″
45.0596± 0.0254 mm
1.7955± 0.0005 ″
45.6057± 0.0127 mm
1.7915± 0.001 ″
45.5041± 0.0254 mm
9.30 ″
236.0 mm
2.500 ″
11.3″
MINIMUM
20−312
5594

20-312 Tool - King Pin “Easy Steer” Bushing Reamer

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 2

REAR AXLE

This section consists of three primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The three primary subsections are:

A - Drive Axle
B1 - Trailing Axle - Self-Steering
B2 - Trailing Axle - Pivoting Arm

SECTION 2A

DRIVE AXLE

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	2A-1
Lubrication	2A-1
Maintenance	2A-3
Torque Specifications	2A-37
Service Tools	2A-41
Specifications	2A-44

GENERAL DESCRIPTION

The drive axle is a Rockwell Standard full floating type with pressed steel housing, fitted with replaceable pressed in steel sleeves. A magnetic drain plug is installed in the bottom of the housing.

The single reduction final drive employs a heavy duty hypoid drive pinion and ring gear. The differential and gear assembly is mounted on tapered roller bearings and lubricated by the differential oil.

The straddle-mounted pinion has two tapered roller bearings in front of the pinion teeth which take the forward and reverse thrust, and a third bearing behind the pinion teeth to carry the radial load.

The standard drive axle ratio is 3.73:1. Optional ratios of 3.21:1, 3.42:1 and 4.10:1 are available.

LUBRICATION

Lubrication recommendations will be found in Section 10 of this manual.

During initial stages of normal operation, tiny metal particles are freed from mating surfaces of moving parts. These metal particles are carried by the lubricant through the assembly and act as lapping compound which accelerates wear of all parts.

To ensure maximum life of the differential and prevent premature failure, the original "factory fill" lubricant should be drained. This also prevents lubricant contamination by differences in "factory fill" and lubricant used by the operator when topping up.

⚠ CAUTION ⚠

Change break-in oil after 1,000 miles (1,600 km) but no later than 3,000 miles (4,800 km).

Fill and drain plugs are located in the axle housing (Figure 1). Magnetic drain plugs perform the vital function of trapping small metallic particles that circulate in the lubricant, through the gears and bearings. They prevent rapid wear and premature failure. The magnet must be strong enough to firmly hold the particles under service conditions. We recommend plugs with elements having a minimum pick-up capacity of 2 pounds of low carbon steel in plate or flat bar form.

Clean all magnetic drain plugs prior to reinstallation.

1. Fill axle housing to the correct level with specified lubricant with the coach on level ground. Use general purpose gear lubricant SAE 140 above 0°F (−18°C) or SAE 90 below 0°F (−18°C).
2. Lubricate universal joint.
3. Drive the coach, unloaded, for one to two miles at speeds not to exceed 25 miles per hour to thoroughly circulate the lubricant throughout the assembly.

For reconditioned axles, follow the same procedures as above, after overhaul.

OIL CHANGE INTERVALS

Gear oil should be changed every 25,000-30,000 miles (40,000-48,000 km) on units run over 60,000 miles (96,000 km) annually.

For units run less than 60,000 miles, the oil should be changed every 12 months regardless of mileage.

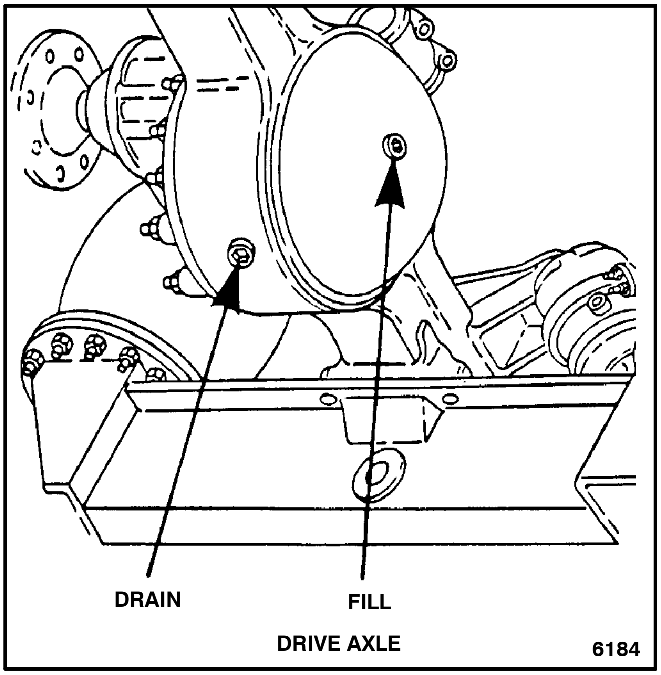


Figure 1. Drive Axle Housing

The Rockwell axle drive unit employs the gravity feed (splash) system of distributing lubricant throughout the assembly. As the coach is initially driven in service, a short period of time is required for the lubricant to reach all areas of the drive units.

GREASE LUBRICATED HUB BEARINGS

Lube Intervals

Check every 30,000 miles (48,000 km) and;

A. Change whenever seals are replaced,

B. When brakes relined, or

C. Every 12 months or, every six months if mileage is less than 30,000 miles per year.

a. If the drive axle shafts are removed for any maintenance or service, it is essential that the grease in the hubs be replaced in the proper quantity. To ensure that the grease lubricated drive axle hub bearings are lubricated after servicing and before the coach is put back into service, the following is required:

NOTE: Use safe shop service practices at all times.

1. At rebuild, before installing the wheel bearings onto the spindle, coat the bearing journals with a film of grease to deter fretting corrosion.

2. Pack bearing with a pressure packer, if possible. If a packer is not available, pack the bearing by hand, forcing the grease in the cavities between the rollers and cage from the large end of the cone.

3. Pack the hub between the two bearing cups with grease to the level of the cups' smallest diameter (Figure 2).

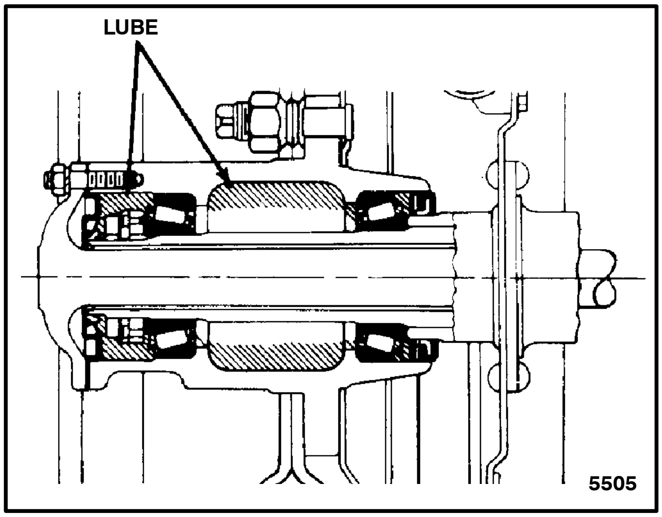


Figure 2. Drive Axle Hub Assembly Grease Level.

OIL LUBRICATED HUB BEARINGS

Lube Intervals

Check every 1000 miles (1600 km) and;

A. Change whenever oil becomes contaminated,

B. When drive unit lube is changed,

C. When seals are replaced,

D. When brakes relined, or

E. At least every 12 months.

If the drive axle shafts are removed for any maintenance or service, it is essential that the oil in the hubs be replaced in the proper quantity. To ensure that the oil lubricated drive axle hub bearings are lubricated after servicing and before the coach is put back into service, the following is required:

NOTE: Use safe shop service practices at all times.

Wipe a film of oil on the inner shoulder of the spindle to prevent rust behind the inner bearing cone.

A. For drive axle hubs with fill holes:

1. Fill hub with one pint (Max.)(0.473 liters) of oil (same as used in differential) directly into each hub through the fill plug hole. **DO NOT OVERFILL.**

2. Check and refill differential housing if required.

3. **DO NOT** attempt to fill the differential through the hub fill oil hole. This could create an overfill condition causing oil to be thrown out the breather hole.

The proper oil level in an oil lubricated bearing hub is shown in Figure 3.

B. For drive axle hubs without fill hole:

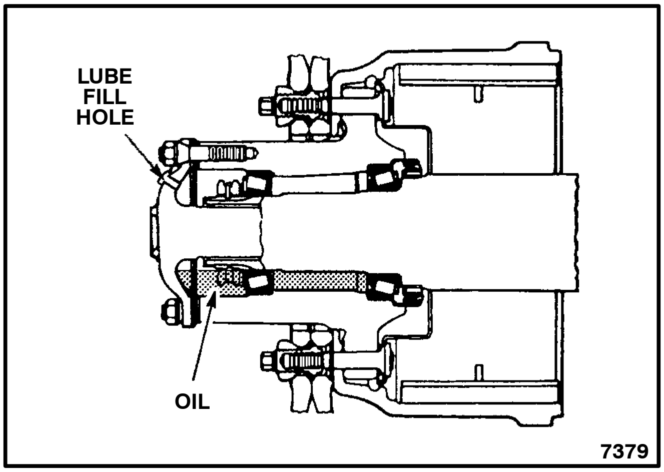


Figure 3 . Drive Axle Hub Assembly Oil Level.

1. Check the drive axle assembly and level if necessary.

2. Fill the differential until the lubricant is at the bottom edge of the fill hole (Figure 1).

3. Tilt the axle to the right and to the left enough to allow oil to flow into the hub cavities. This may be accomplished by jacking up the axle from each end. Keep the axle in each tilted position for one minute to allow the hub cavities to fill. Approximately one pint (0.473 liters) of oil will be trapped in each hub cavity.

4. With the drive axle back on a level position, add oil to the differential until it is to the bottom of the fill hole (approximately two pints).

MAINTENANCE

Careful adherence to maintenance and lubrication procedures will go a long way toward successful operation.

The most common causes of drive axle carrier failures are spinout, shock, fatigue and poor lubrication. Spinout is defined as excessive differential action. On a single rear axle, main differential spinout occurs when one wheel remains stationary while the other wheel is spinning (Figure 4). The relatively high speed differences between the mating parts generate heat, and the rate of heat generation increases with the speed differences. When the heat becomes excessive it can cause galling of the journals of the cross and the mating differential pinion bores. In extreme cases of spinout, enough heat may be generated to weld the differential pinion to the cross and cause a catastrophic failure.

Shock is another common cause of carrier failure. It results from a rapidly applied load or force that is severe enough to exceed the strength of the carrier component and cause it to crack or fail instantly. There are a number of operating conditions which can result in a shock failure:

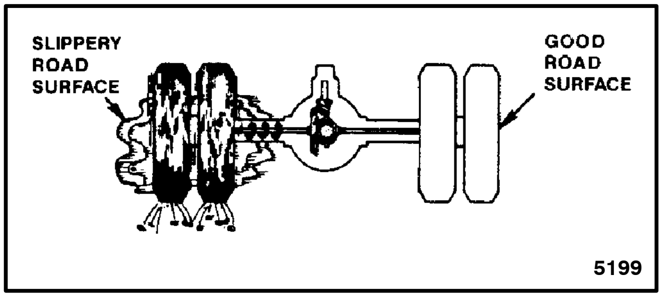


Figure 4. Drive Axle Spinout

A. Hitting dry pavement with a spinning wheel.
B. Missing a shift.
C. “Popping” the clutch.
D. Reverse interlock failure.

If the failed part separates into two or more pieces, the operator will usually realize the fact immediately. But if the part is only cracked, the operator may not be aware of the damage until sometime later. Depending on the severity of the crack in the part, the final failure may not occur until many miles later. The crack will be a point of origin for a fatigue failure, and can progress until the part fails. Thus the failure could happen while the coach is being operated under normal conditions.

Fatigue is another type of failure in axle carriers, one that results from repeated loadings of a component. A single application of these loads or forces is not great enough to damage the part but repeated applications gradually weaken it to the point of failure. Fatigue failures that occur in drive axle carriers have two sources:

1. Exceeding the GVW/GCW rating of the carrier
2. Shock loads.

When the coach is operated at a weight in excess of what the carrier was designed for, the life of the components is reduced. The rated GVW/GCW of a carrier changes with the road grade and surface. As the grade increases, so does the effort (torque) required to move a coach loaded to a given GVW/GCW. Again, as the road surface changes from hard to soft, rolling resistance increases and more torque is needed. Thus, a coach loaded to a given GVW/GCW will have a reduced carrier life when operated in hilly or mountainous terrain as opposed to being operated on level ground. The same is true for operation on soft or unimproved surfaces as compared to hard surface roads.

The fourth common cause of axle carrier failures originates with the lubricant, or with lubricant change practices. The lubricant which protects the axle components has three key functions:

A. To reduce friction between parts.
B. To carry heat away from parts.
C. To carry wear particles and dirt away from parts.

When lubricant failure occurs, it is generally the result of improper maintenance and has its roots in one of three basic problem areas:

A. Low lubricant level.

B. Improper type of lubricant or lubricant with depleted additives.

C. Contaminated lubricant.

DRIVE AXLE REMOVAL

Removal of the entire axle is recommended to facilitate repair work on the carrier. Axle removal and replacement instructions follow.

Block front wheels of the coach to prevent rolling. Raise the rear end of the coach with jacks until the bottom of the body is approximately 18 inches (457.2 mm) from the floor. Block the body in this position as outlined in Section 3 under Coach Jacking Points.

⚠ CAUTION ⚠

Do not allow the rear axle assembly to hang on the air springs. Damage to the air springs may result.

1. Exhaust air pressure from the suspension system air tank by opening the drain cock on the bottom of air filter.
2. Disconnect the sway bar links.
3. Disconnect the brake chamber hoses.
4. Disconnect the propeller shaft as outlined in Section 14.
5. Disconnect both height control valve links from brackets, and pull down on each height control valve arm to exhaust air from the air springs.
6. Disconnect both ends of all four radius rods as outlined in this section under Radius Rods.
7. Remove shock absorbers.
8. Disconnect air springs from the suspension supports.
9. Lower the axle and carefully remove from under the coach body.

Replacement is the reverse of removal.

CARRIER REPLACEMENT

The single reduction differential carrier is front mounted into the axle housing (Figures 5 and 6). This carrier has a hypoid drive pinion and ring gear set and bevel gears in the differential assembly.

A straight roller bearing (spigot) is mounted on the head of the drive pinion. All other bearings in the carrier are tapered roller bearings.

When the carrier operates, there is normal differential action between the wheels all the time.

Removal of Carrier Assembly from Axle Housing

1. After the axle has been removed from the coach, support it securely under the axle shaft housings. Support the axle at a height sufficient to allow a roller jack to pass under the center (banjo) of the axle.
2. Remove the plug from bottom of axle housing and drain lubricant from the assembly.
3. Remove the stud nuts and washers from the flanges of both axle shafts.
4. Loosen the tapered dowels in the flanges of both axle shafts as follows.

⚠ WARNING ⚠

Wear safe eye protection. Do not hit the round driving lugs on the head of axle shafts. Lugs can break and cause injury.

A. Hold a 1½-inch-diameter brass drift against the center of the axle shaft, inside the round driving lugs (Figure 7).

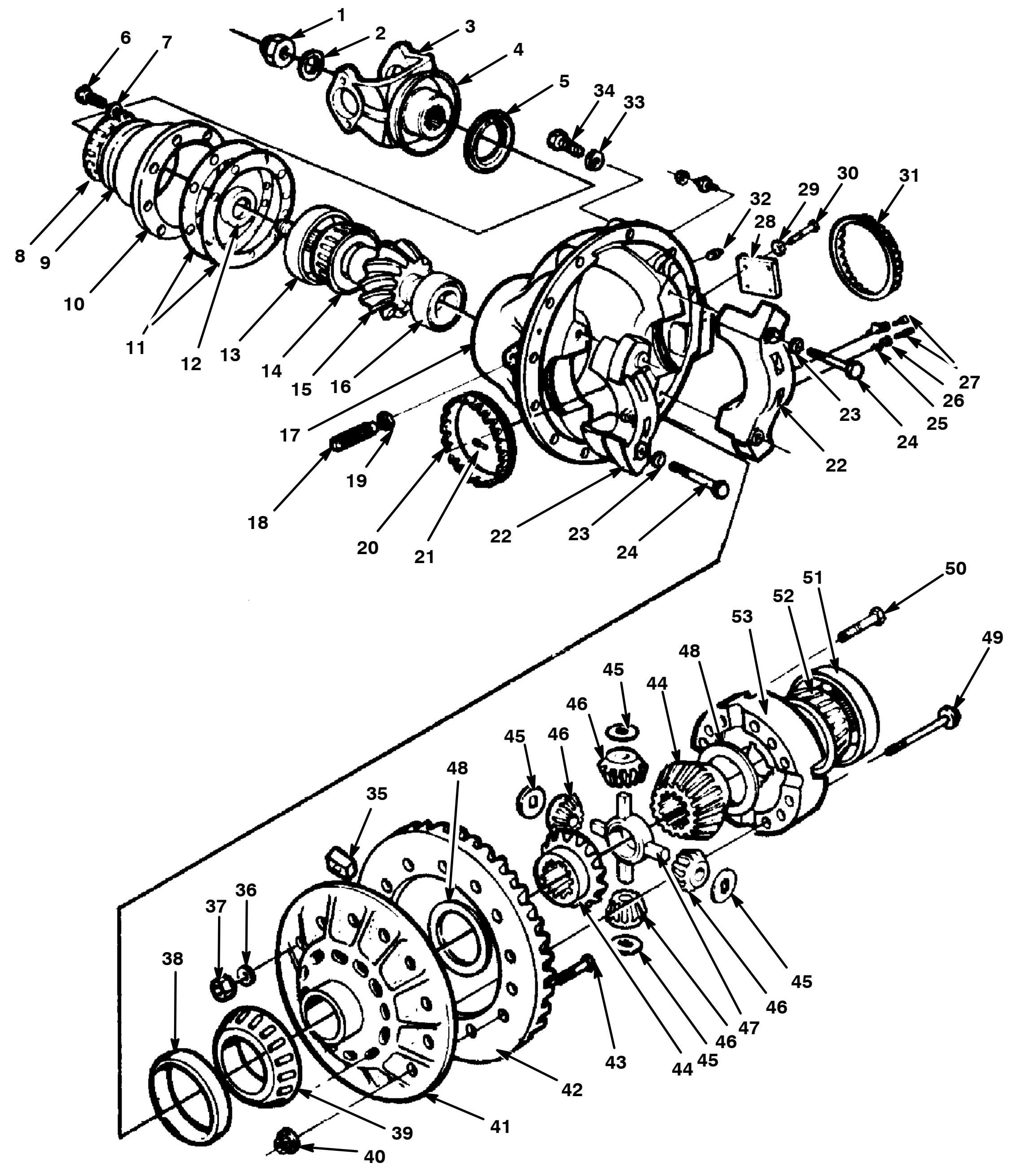
NOTE: A 1½-inch-diameter brass hammer can be used as a drift.

B. Hit the end of the drift with a large hammer (five to six pounds) and the axle shaft and tapered dowels will loosen.

⚠ CAUTION ⚠

Do not use a chisel or wedge to loosen the axle shafts and dowels. The chisel or wedge can damage the hub, axle shafts and oil seals.

5. Remove the tapered dowels and both axle shafts from the axle assembly.
6. Place a hydraulic roller jack under the differential carrier to support the assembly (Figure 8).
7. Remove all but the top two carrier-to-housing capscrews or stud nuts and washers.
8. Loosen the top two carrier-to-housing fasteners and leave attached to the assembly. The fasteners will hold the carrier in the housing.
9. Loosen the differential carrier in the axle housing. Use a leather mallet to hit the mounting flange of carrier at several points.



1. Nut - Drive Pinion
2. Washer - Drive Pinion
3. Input Yoke or Flange
4. Deflector
5. Oil Seal
6. Capscrew - Bearing Cage
7. Washer
8. Bearing Cone - Pinion Outer
9. Bearing Cup - Pinion Outer
10. Bearing Cage - Drive Pinion
11. Shims
12. Spacer - Pinion Bearing
13. Bearing Cup - Pinion Inner
14. Bearing Cone - Pinion Inner
15. Drive Pinion
16. Spigot Bearing
17. Carrier
18. Thrust Screw
19. Jam Nut - Thrust Screw
20. Adjusting Ring - LH
21. Cotter or Pin
22. Caps - Differential Bearing
23. Washers
24. Capscrews - Differential Bearing Cap
25. Lock Plate - Adjusting Ring
26. Washers - Lock Plate
27. Capscrews - Lock Plate
28. Cover - Air Cylinder Opening
29. Washers - Cover
30. Capscrews - Cover
31. Adjusting Ring - RH
32. Plug - Oil Fill Hole (Carrier)
33. Washer - Capscrew Plug
34. Capscrew Plug - Sensor Hole
35. Thrust Block
36. Washers - Differential Case
37. Nuts - Differential Case
38. Bearing Cup - Differential LH
39. Bearing Cone - Differential LH
40. Nuts - Ring Gear & Case Half
41. Case Half - Flange
42. Ring Gear
43. Bolts or Rivets - Ring Gear & Case Half
44. Side Gears - Differential
45. Thrust Washeers - Differential Pinion
46. Pinions - Differential
47. Spider - Differential
48. Thrust Washers - Differential Side Gear
49. Capscrews - Differential Case
50. Bolts - Differential Case
51. Bearing Cup - Differential RH
52. Bearing Cone - Differential RH
53. Case Half - Plain

5201

Figure 5. Single Reduction Differential Carrier

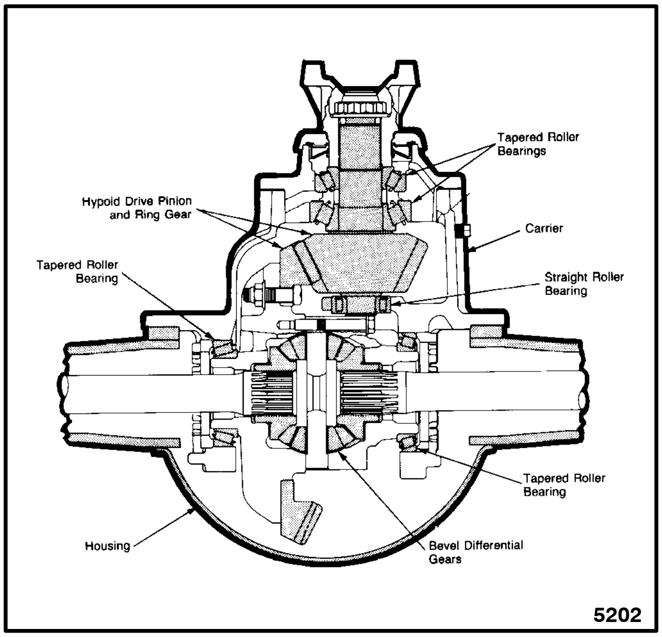

Tapered Roller Bearings
Hypoid Drive Pinion and Ring Gear
Carrier
Tapered Roller Bearing
Straight Roller Bearing
Tapered Roller Bearing
Housing
Bevel Differential Gears
5202

Figure 6. Single Reduction Differential Carrier

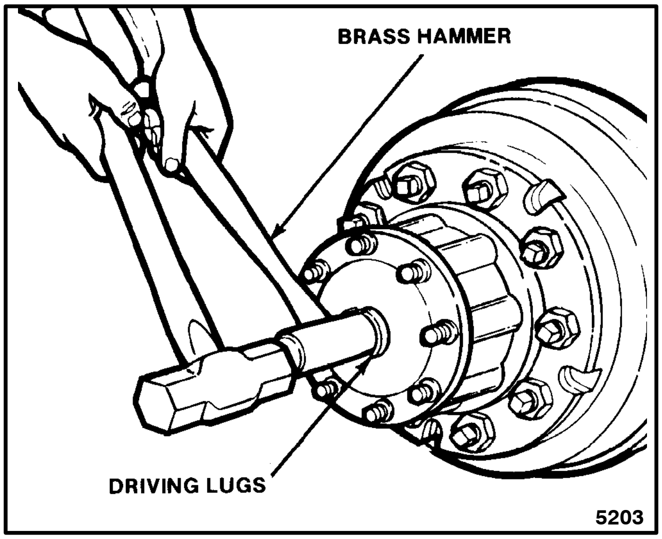

BRASS HAMMER
DRIVING LUGS
5203

Figure 7. Loosening Shaft and Dowels

NOTE: Some carrier models have threaded puller screw holes in the mounting flange. Puller screws can be used to loosen and pull the carrier from the axle housing. If puller screws are used, clean the threaded holes before the puller screws are installed.

10. After carrier is loosened, remove the top two fasteners. Carefully remove the carrier from the axle housing using the hydraulic roller jack. Use a pry bar that has a round end to help remove the carrier from the housing.

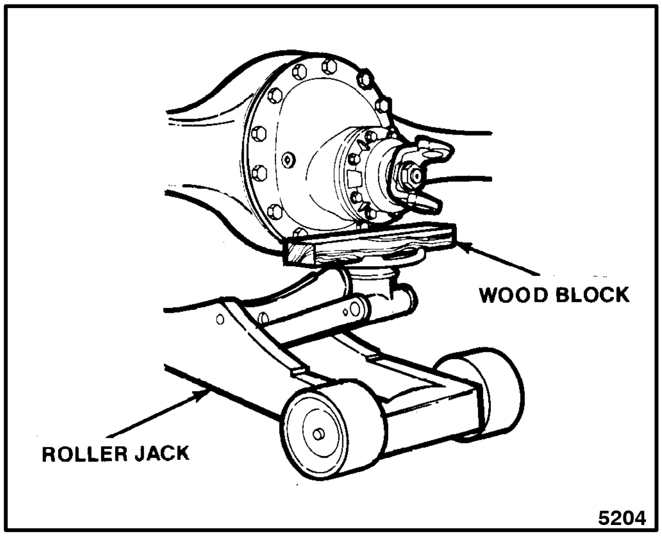

WOOD BLOCK
ROLLER JACK
5204

Figure 8. Supporting Carrier Assembly

CAUTION

When using a pry bar, be careful not to damage the carrier or housing flange. Damage to these surfaces will cause oil leaks.

11. Remove and discard the carrier-to-housing gasket.

12. Lift the differential carrier by the input yoke and put the assembly in a repair stand (Figure 9). Such a stand may be purchased; see tools at end of this section. Do not lift the carrier assembly by hand; use a lifting tool.

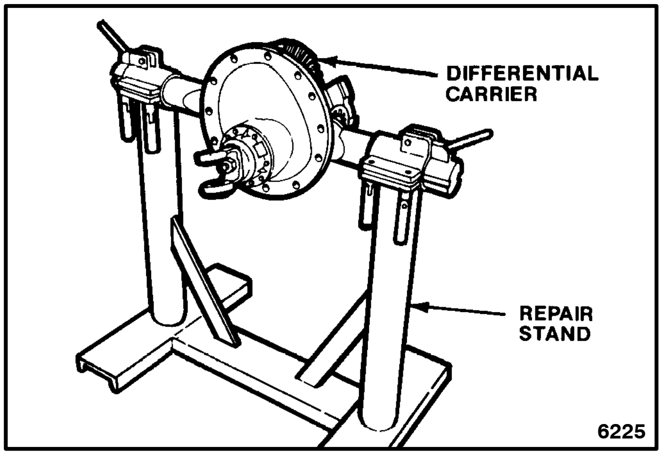

DIFFERENTIAL CARRIER
REPAIR STAND
6225

Figure 9. Carrier Mounted in Repair Stand

Removal of Differential and Ring Gear

NOTE: Before starting work on the differential carrier, inspect the hypoid gear set for damage. If the inspection shows no damage, the same gear set can be used again. Using a dial indicator, measure the backlash of the gear set and make a note of it (Figure 10). This measurement will be needed when the gear set is reinstalled.

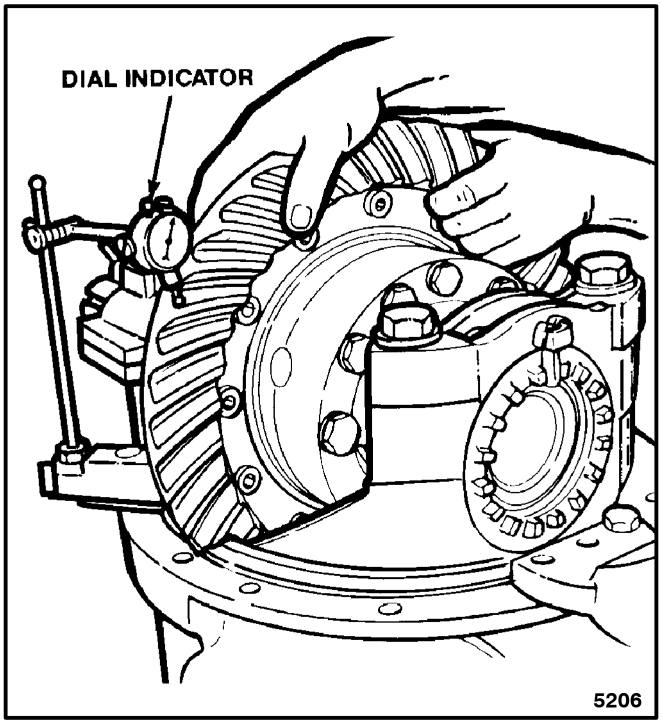


Figure 10. Measuring Backlash

1. Loosen the jamnut on the thrust screw.

2. Remove the thrust screw and jamnut from the differential carrier (Figure 11).

3. Rotate the differential carrier in the repair stand until the ring gear is at the top of the assembly.

4. Mark one carrier leg and bearing cap for the purpose of correctly matching the parts when you assemble the carrier. A center punch and hammer can be used to mark the parts (Figure 12).

5. Remove the cotter keys, pins or lock plates that hold the two bearing adjusting rings in position. Use a small drift and hammer to remove pins. Each lock plate is held in position by two capscrews (Figure 13).

6. Remove the capscrews and washers that hold the two bearing caps on the carrier. Each cap is held in position by two capscrews and washers (Figure 14).

7. Remove the bearing caps and bearing adjusting rings from the carrier (Figure 15).

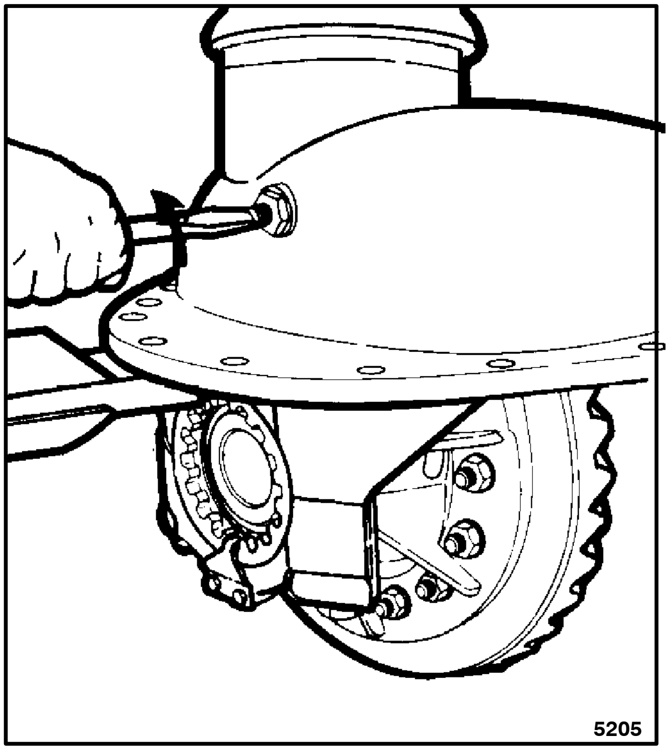


Figure 11. Removing Thrust Screw and Jamnut

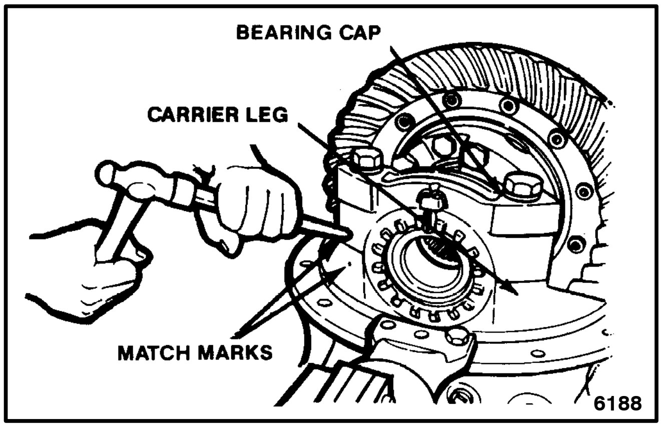


Figure 12. Making Match Marks

8. Safely lift the main differential and ring gear assembly from the carrier. Put the assembly on a work bench (Figure 16).

Disassembling the Differential and Ring Gear Assembly

1. If the matching marks on the case halves of the differential assembly are not visible, mark each case half with a center punch and hammer. The purpose of the marks is to match the plain half and flange half correctly when you assemble the Carrier (Figure 17).

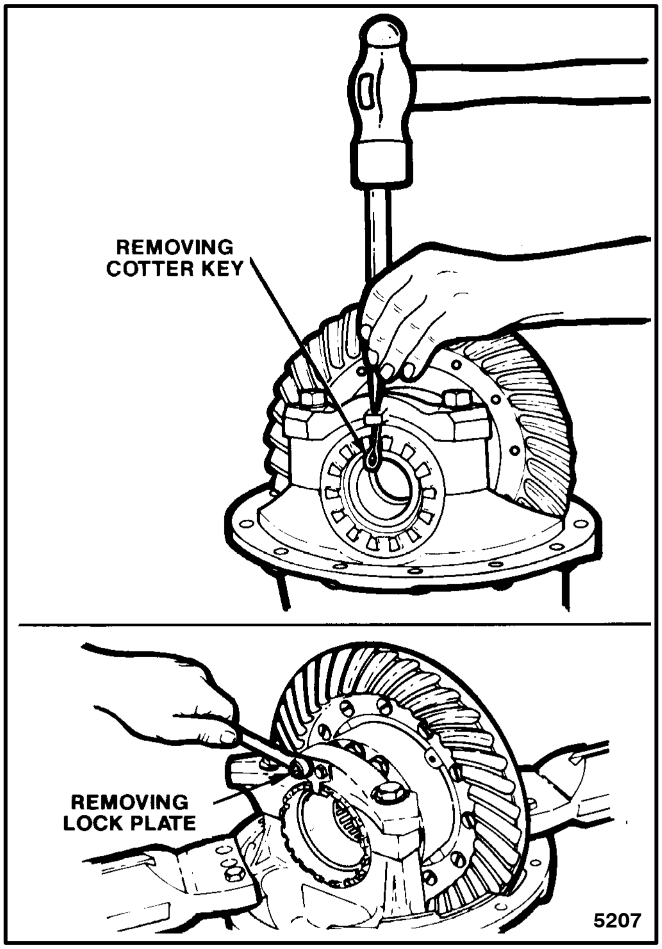

REMOVING COTTER KEY
REMOVING LOCK PLATE
5207

Figure 13. Cotter Key/Lock Plate Removal

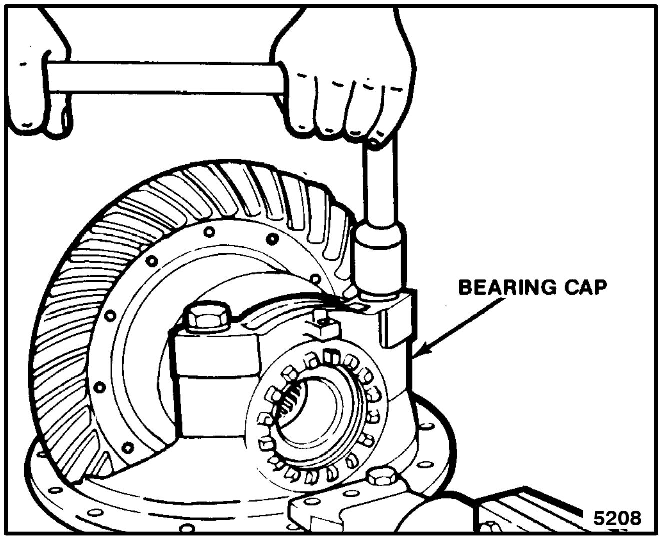

BEARING CAP
5208

Figure 14. Removal of Bearing Cap Capscrews

2. Remove the lock wire, capscrews and washers or bolts, nuts and washers that hold the case halves together.

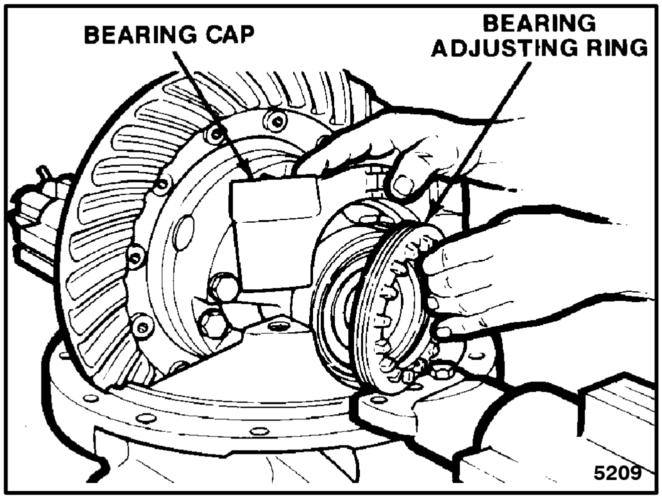

BEARING CAP
BEARING ADJUSTING RING
5209

Figure 15. Removing Bearing Cap and Adjusting Ring

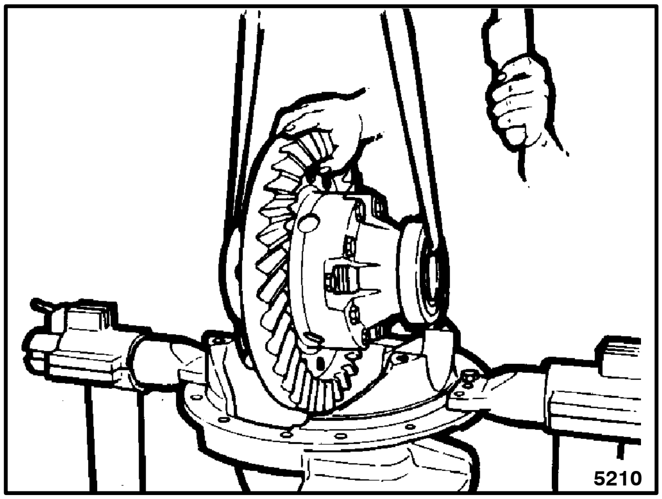


Figure 16. Lifting Differential and Ring Gear From Carrier

⚠ WARNING ⚠

Wear eye protection. do not hit steel parts with a steel hammer. Parts can break and cause injury.

3. Separate the case halves. If necessary, use a brass, plastic or leather mallet to loosen the parts.

4. Remove the differential spider (cross), four pinion gears, two side gears and six thrust washers from inside the case halves (Figure 18).

5. If the ring gear needs to be replaced, remove the bolts, nuts and washers that hold the gear to the flange case half; if rivets hold the ring gear to the flange case half, remove the rivets as follows.

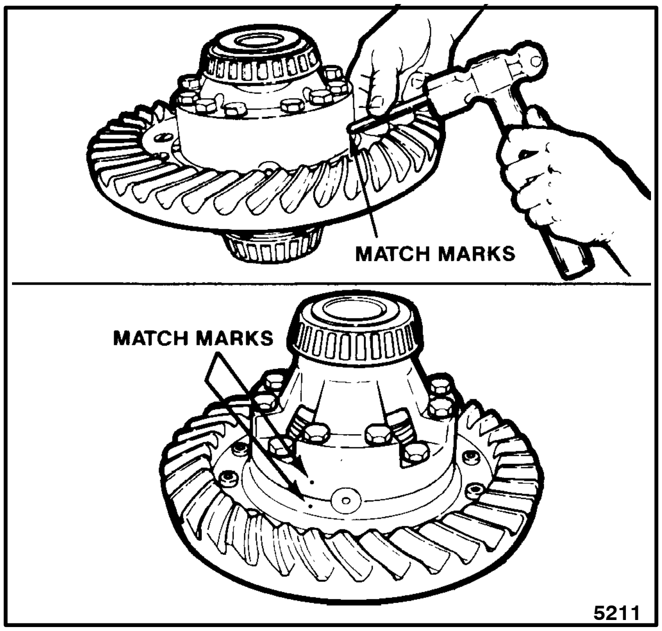

MATCH MARKS
MATCH MARKS
5211

Figure 17. Putting Match Marks On Case Halves

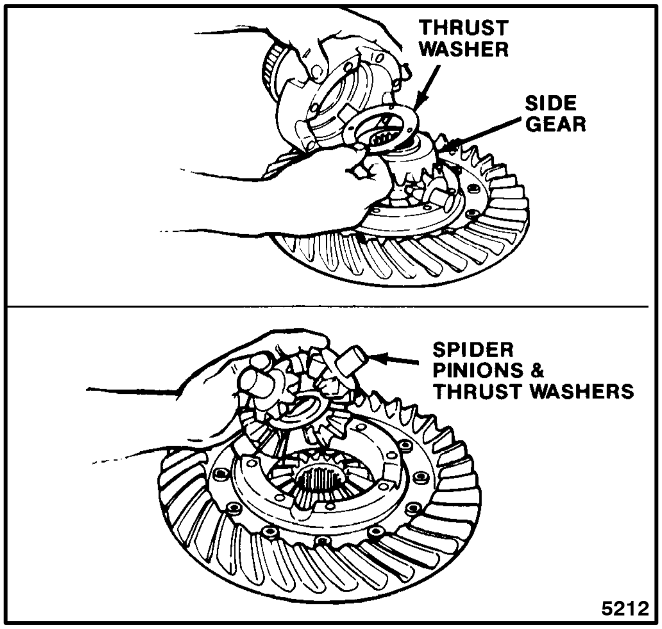

THRUST WASHER
SIDE GEAR
SPIDER PINIONS & THRUST WASHERS
5212

Figure 18. Disassembling Differential

A. Carefully center punch each rivet head in the center, on the ring gear side of the assembly.

B. Drill each rivet on the ring gear side of the assembly to a depth equal to the thickness of one rivet head. Use a drill bit that is $\frac{1}{32}$ of an inch smaller than the body diameter of the rivets.

C. Press the rivets through holes in the ring gear and flange case half. Press from the drilled rivet head.

CAUTION

Do not remove the rivets or rivet heads with a chisel and hammer. The chisel can damage the flange case half.

6. Separate the case half and ring gear using a press. Support the assembly under the ring gear with metal or wood blocks and press the case half through the gear (Figure 19).

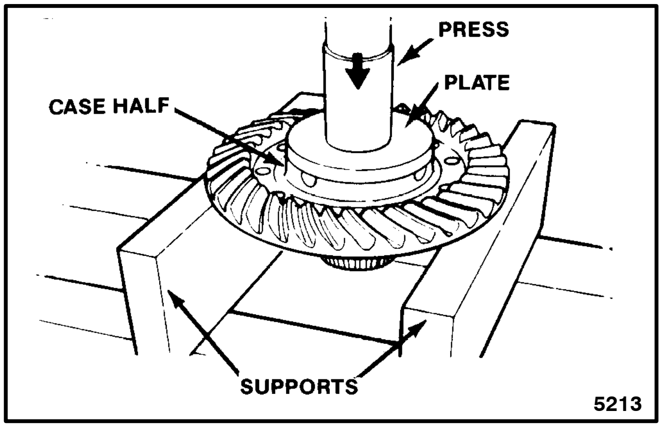

PRESS
PLATE
CASE HALF
SUPPORTS
5213

Figure 19. Pressing Case Half From Gear

7. If the differential bearings need to be replaced, remove the bearing cones from the case halves. Use a bearing puller or press (Figure 20).

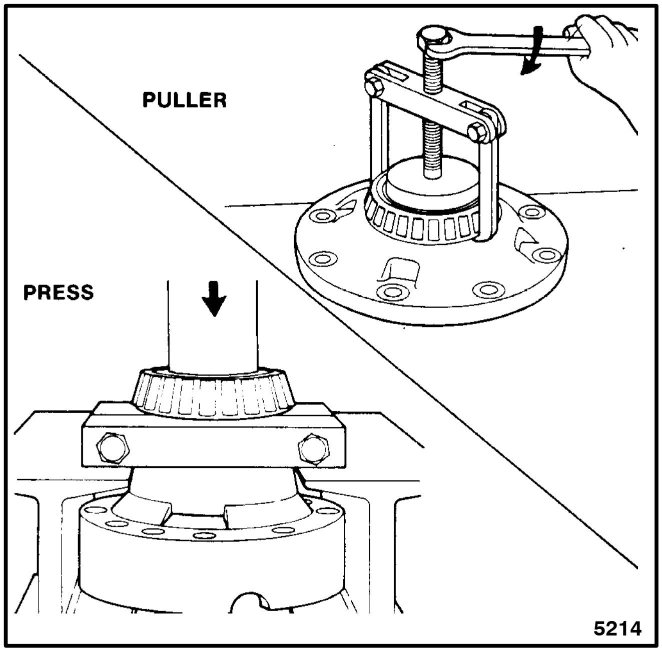

PULLER
PRESS
5214

Figure 20. Removing Bearing From Case Half

Removing Drive Pinion and Bearing Cage from Carrier

1. Fasten a yoke bar to the input yoke. The bar will hold the drive pinion in position when the nut is removed.

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Remove the nut and washer from the drive pinion (Figure 21).

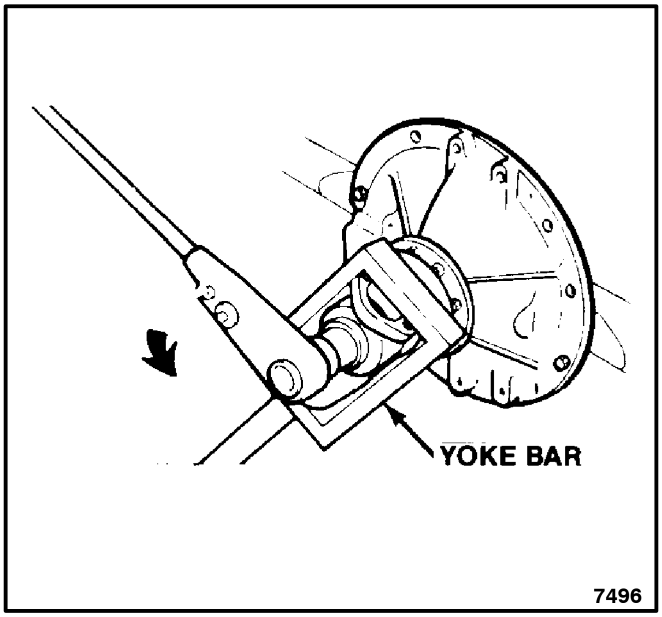


Figure 21. Removing Drive Pinion Nut

2. Remove the yoke bar.

3. Remove the yoke from the drive pinion. If the yoke is tight on the pinion, use a puller for removal (Figure 22).

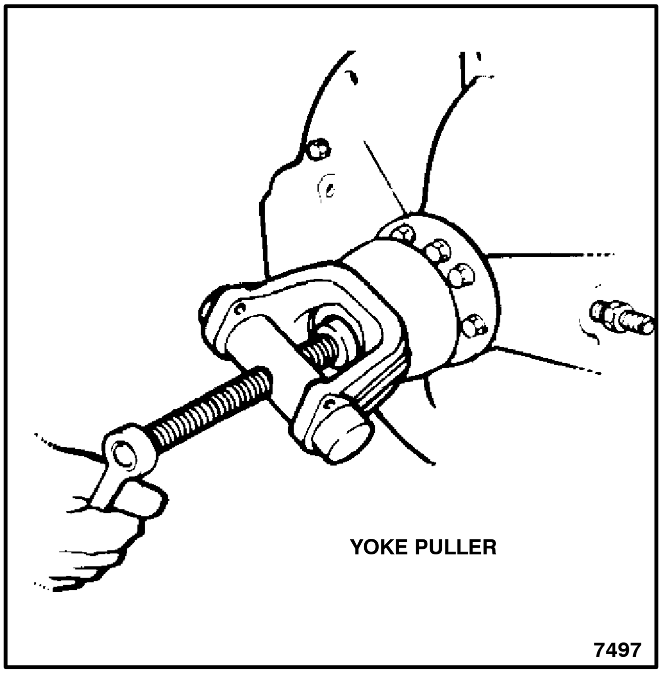


Figure 22. Removing Yoke or Flange

⚠ CAUTION ⚠

Do not use a hammer or mallet to loosen and remove the yoke. A hammer or mallet can damage the parts and cause runout or alignment problems.

4. Remove the capscrews and washers that hold the bearing cage in the carrier (Figure 23).

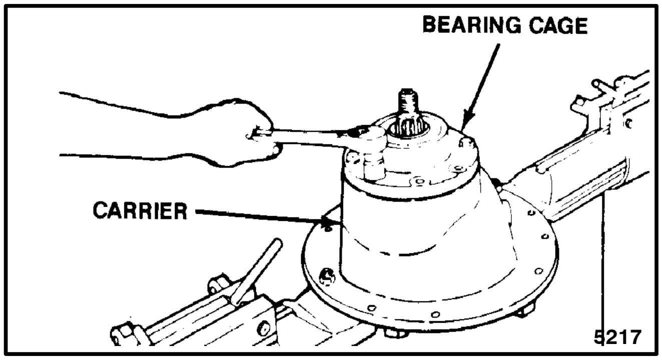


Figure 23. Removing Bearing Cage Capscrews

5. If the pinion seal is damaged, remove the seal from the cover. Use a press and sleeve or seal driver. If a press is not available, use a screwdriver or small pry bar for removal. Discard the pinion seal.

6. The pinion seal is mounted in the outer bore of the bearing cage. Remove the seal after the drive pinion is removed from the bearing cage.

7. Remove the drive pinion, bearing cage and shims from the carrier. If the bearing cage is tight in the carrier, hit the bearing cage at several points around the flange areas with a leather, plastic or rubber mallet (Figure 24).

⚠ WARNING ⚠

Wear safe eye protection. Do not hit steel parts with a steel hammer. Parts can break and cause injury.

NOTE: Some bearing cages have threaded puller screw holes in the mounting flange. Puller screws can be used to loosen and pull a tightly fitted cage from the carrier. If puller screws are used, clean the threaded holes before the puller screws are installed (Figure 25).

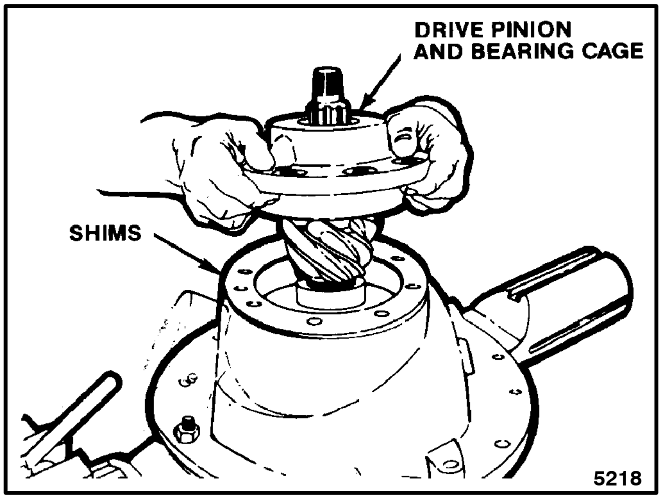

DRIVE PINION AND BEARING CAGE
SHIMS
5218

Figure 24. Removing Drive Pinion and Bearing Cage

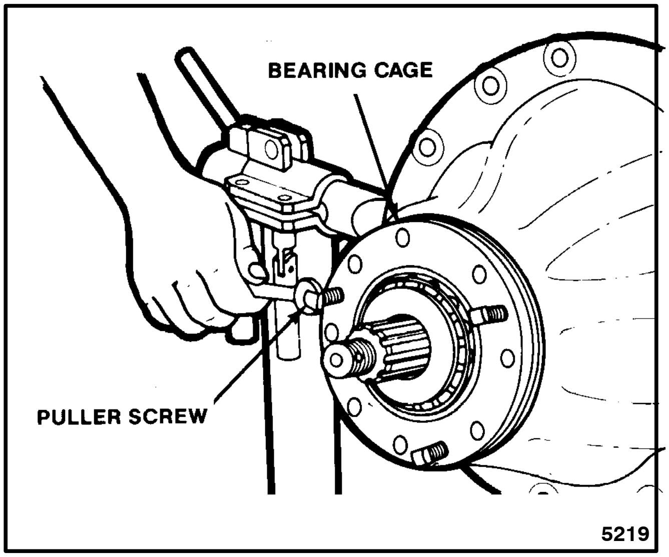

BEARING CAGE
PULLER SCREW
5219

Figure 25. Removing Bearing Cage Using Puller Screws

CAUTION

Do not use a pry bar to remove the bearing cage from the carrier. A pry bar can damage the bearing cage, shims and carrier.

8. If the shims are in good condition, keep the shims together for use later when the carrier is assembled.

9. If shims are to be discarded because of damage, first measure the total thickness of the pack. Make a note of the dimension. The dimension will be needed to calculate the depth of the drive pinion in the carrier when the gear set is installed.

Drive Pinion and Bearing Cage Disassembly

1. Put the drive pinion and bearing cage in a press. (Figure 26)

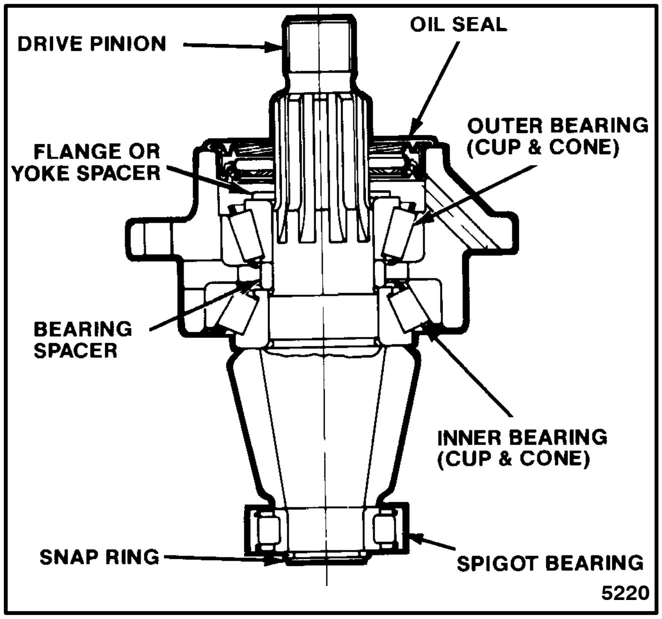

DRIVE PINION
OIL SEAL
OUTER BEARING (CUP & CONE)
FLANGE OR YOKE SPACER
BEARING SPACER
INNER BEARING (CUP & CONE)
SNAP RING
SPIGOT BEARING
5220

Figure 26. Pinion And Bearing Cage Assembly

The pinion shaft must be toward the top of the assembly. Support the bearing cage under the flange area with metal or wood blocks. Press the drive pinion through the bearing cage (Figure 27).

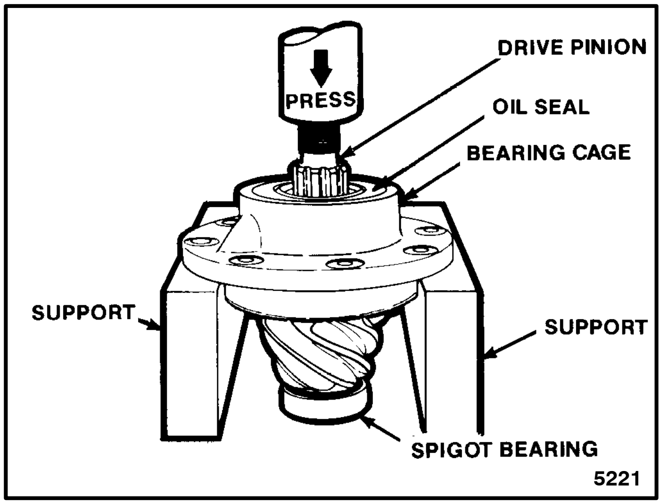

PRESS
DRIVE PINION
OIL SEAL
BEARING CAGE
SUPPORT
SUPPORT
SPIGOT BEARING
5221

Figure 27. Removing Drive Pinion From Bearing Cage

NOTE: The inner bearing cone and bearing spacer or spacers will remain on the pinion shaft.

2. If a press is not available, use a leather, plastic or rubber mallet to drive the pinion through the bearing cage.

3. If the pinion seal is mounted directly in the outer bore of the bearing cage, remove the seal at this time. Use a screwdriver or small pry bar for removal. After the seal is removed, lift the outer bearing cone from the cage (Figure 28).

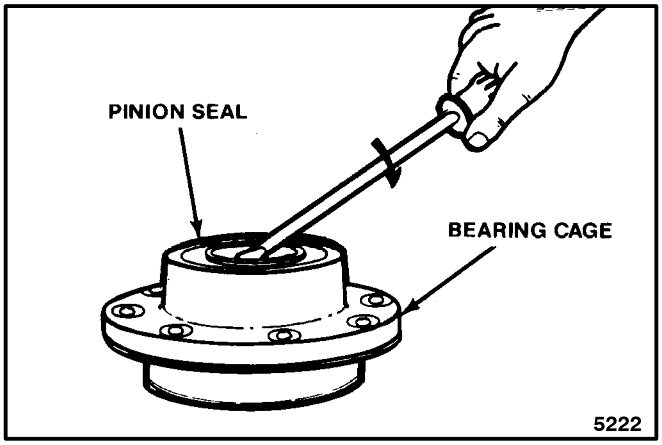


Figure 28. Removing Pinion Seal

⚠ CAUTION ⚠

Be careful when using a screwdriver or pry bar to remove the seal. Do not damage the bore wall. Damage to the bore can cause oil leaks.

4. If the pinion bearings need to be replaced, remove the inner and outer bearing cups from the inside of the cage. Use a press and sleeve, bearing puller or a small drift and hammer. The type of tool used depends on the design of the bearing cage. When a press is used, support the bearing cage under the flange area with metal or wood blocks (Figure 29).

5. If the pinion bearings need to be replaced, remove the inner bearing cone from the drive pinion with a press or bearing puller. The puller MUST fit under the inner race of the cone to remove the cone correctly without damage (Figure 30).

6. If the spigot bearing needs to be replaced, put the drive pinion in a vise. Install a soft metal cover over each vise jaw to protect the drive pinion.

7. Remove the snap ring from the end of drive pinion with snap ring pliers that expand (Figure 31).

8. Remove the spigot bearing from the drive pinion with a bearing puller (Figure 32).

NOTE: Some spigot bearings are a two-piece assembly. Remove the inner race from the pinion with a bearing puller. Remove the outer race/roller assembly from carrier with a drift or a press.

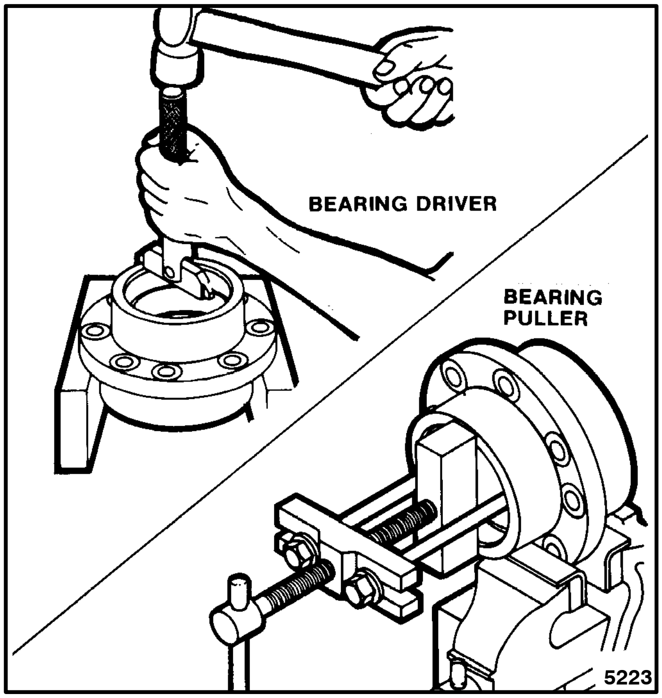


Figure 29. Removing Bearing Cups

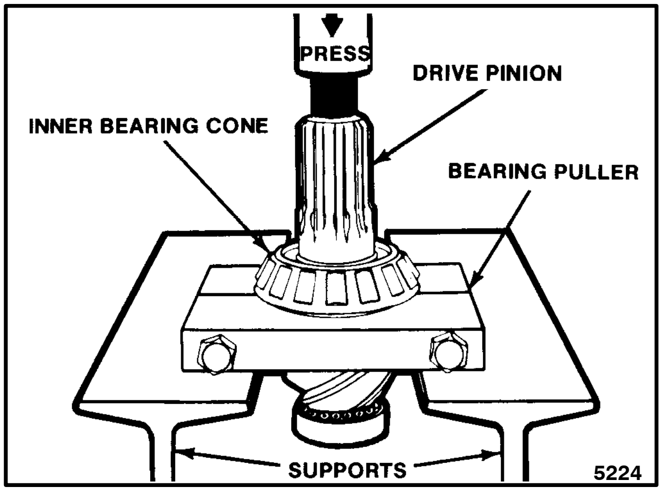


Figure 30. Removing Inner Bearing Cone

Cleaning and Inspection

CLEANING PARTS

It is important that all parts being reassembled are clean. Foreign material in the assembly will cause abrasion of parts and shorten their life.

To Clean Ground and Polished Parts:

1. Use a cleaning solvent to clean ground or polished parts or surfaces. Kerosene or diesel fuel oil can be used for this purpose. Do not use gasoline. Follow the solvent manufacturer's instructions for safe use to prevent injury.

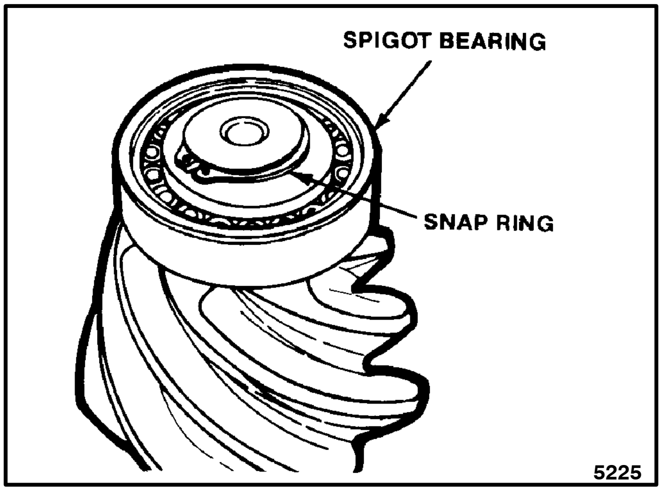


Figure 31. Snap Ring on Drive Pinion

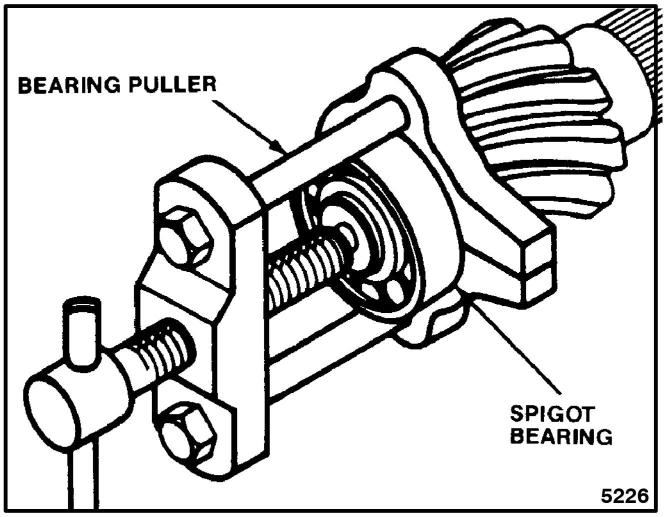


Figure 32. Removing Spigot Bearing From Drive Pinion

2. Use a tool with a flat blade if required to remove gasket material from parts. Be careful not to damage the ground surfaces.

3. Do not clean ground or polished parts in a hot solution tank, water, steam or alkaline solutions.

To Clean Rough Parts:

1. Clean rough parts the same as cleaning ground and polished parts.

2. Rough parts can be cleaned in hot solution tanks with a weak alkaline solution.

3. Parts must remain in hot solution tanks until completely cleaned and heated. Follow the alkaline product manufacturer's instructions for safe use to prevent injury.

4. Parts must be washed with water until the alkaline solution is removed.

To Clean Axle Assemblies:

1. A complete axle assembly can be steam cleaned on the outside to remove dirt.

2. Before the axle is steam cleaned, close or put a cover over all openings in the axle assembly. Examples of openings are breathers or vents in air chambers.

To Dry Parts That Have Been Cleaned:

1. Parts must be dried immediately after cleaning and washing.

2. Dry the parts using soft, clean paper or cloth rags.

3. Except for bearings, parts can be dried with compressed air.

⚠ **CAUTION** ⚠

Damage to bearings can be caused if dried by rotating with compressed air.

To Prevent Corrosion and Rust on Cleaned Parts:

1. Apply axle lubricant to cleaned and dried parts that are not damaged and are to be assembled.

2. To store parts, apply a special material that prevents corrosion and rust to all surfaces. Wrap them in a special paper that prevents corrosion and rust.

INSPECTING PARTS

It is very important to inspect all parts carefully and completely before the axle or carrier is assembled. Check all parts for wear and replace damaged parts. Replacement of damaged or worn parts now will prevent failure of the assembly later.

1. **Inspect Tapered Roller Bearings:** Inspect the cup, cone, rollers and cage of all tapered roller bearings in the assembly. If any of the following conditions exists, the bearing must be replaced.

A. The center of large diameter end of rollers worn level with or below the outer surface.

B. The radius at large diameter end of rollers worn to a sharp edge.

C. A visible roller groove in the cup or cone inner race surfaces. The groove can be seen at the small or large diameter end of both parts.

D. Deep cracks or breaks in the cup, cone inner race or roller surfaces.

E. Bright wear marks on the outer surface of the roller cage.

F. Damage on rollers and on surfaces of the cup and cone inner race that touch the rollers.

G. Damage on the cup and cone inner race surfaces that touch the rollers.

2. **Inspect Hypoid Drive Pinion and Ring Gear Sets**: Inspect hypoid pinions and gears for wear or

damage. Gears that are worn or damaged must be replaced.

CAUTION

Hypoid drive pinions and ring gears are machined in matched sets. When a drive pinion or ring gear of a hypoid set needs to be replaced, both drive gear and pinion must be replaced at the same time.

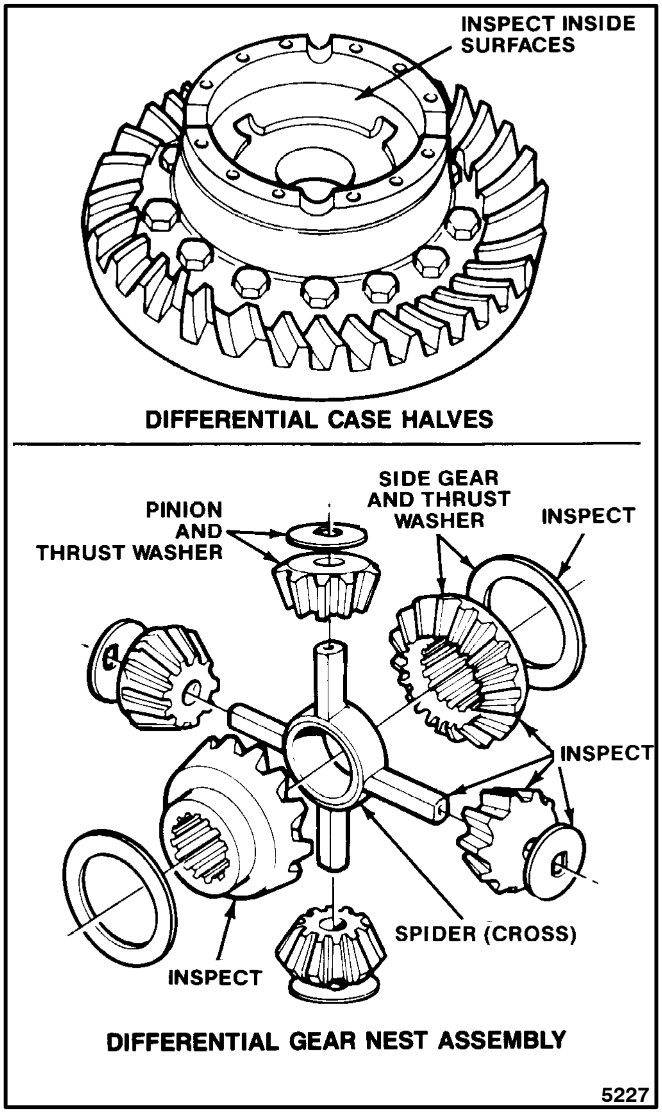


Figure 33. Inspection Points

3. **Inspect the Main Differential Assembly:** Inspect the following parts for wear or stress. Parts that are damaged must be replaced (Figure 33).

A. Inside surfaces of both case halves.

B. Both surfaces of all thrust washers.

C. The four trunnion ends of the spider (cross).

D. Teeth and splines of both differential side gears.

E. Teeth and bore of all differential pinions.

CAUTION

Always replace thrust washers, differential side gears and pinion gears in sets. A higher stress on parts and early failure of the assembly will occur if a new part is used with parts that are old or worn.

4. **Inspect Axle Shafts:** Inspect axle shafts for wear and cracks at the flange, shaft and splines. Replace axle shaft if required.

REPAIRING AND REPLACING FASTENERS

All threads of the fasteners and holes in the assembly must be without damage and clean so that accurate adjustments and correct torque values can be applied to the fasteners and parts.

Use the following procedures to ensure that all fasteners and threaded holes are in good condition.

1. Replace any fastener if the corners of the head are worn or distorted.

2. Clean and repair threads of fasteners and holes. Use a die or tap of the correct size or a fine file for this purpose.

3. Replace any damaged washer.

4. When installing new fasteners of the Dri-Loc type, do not apply adhesives or sealants to the new fastener or to the hole. The Dri-Loc adhesive will not function correctly if this is done.

5. When the old fasteners are being reused:

A. Clean the oil and dirt from threaded holes. There is no special cleaning required and it is not necessary to remove the old Dri-Loc adhesive from threads.

B. Apply four or five drops of Rockwell Liquid Adhesive or Loctite 277 to threaded holes only. Make sure the adhesive is on the threads.

CAUTION

Do not apply adhesive to the fastener threads. Air pressure in the hole will push the adhesive out as the fastener is installed.

INSTALLING FASTENERS

When installing the fasteners, torque to the required value for that size fastener. See Torque Value Chart later in this section. Always use a torque wrench (Figure 34).

CHECKING TORQUE OF UNREMOVED FASTENERS

If Dri-Loc fasteners do not require removal from components, check the fasteners for correct torque value as follows:

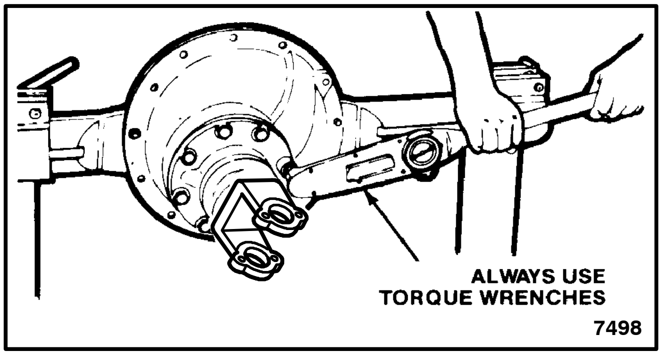


Figure 34. Reinstalling Fasteners

1. Apply the minimum amount of torque required for that size fastener. See the torque chart later in this section. The fastener must not rotate (Figure 34).

2. If the fastener rotates any amount, remove the fastener from the component and apply adhesive to the threaded hole. Follow the procedure for installing old Dri-Loc fasteners.

REMOVAL OF “DRI-LOC” FASTENERS

If it is difficult to remove Dri-Loc fasteners from components, the strength of Dri-Loc, Rockwell adhesive or Loctite 277 can be decreased by heating. Use the following procedure:

1. Heat the fastener for three to five seconds only and try to loosen the fastener with a wrench. Do not use an impact wrench to loosen the fastener or hit the fastener with a hammer.

2. Repeat step 1 until the fastener can be removed.

⚠ CAUTION ⚠

Do not exceed 350°F (+177°C) maximum. Heating must be done slowly to prevent thermal stresses in the other components.

REPAIRING PARTS

Remove nicks, mars and burrs from parts having machined or ground surfaces. Use a fine file, india stone, emery cloth or crocus cloth for this purpose.

REPAIRING AXLE HOUSING

Certain repairs may be made to the axle housing by welding as explained in the following paragraphs. However, attempted repairs of the housing by bending or straightening will cause poor or unsafe operation of the axle and early failure can result.

NOTE: Refer to the welding caution in the introductory pages of this manual before starting any welding operation.

Following is the vendor-allowed welding procedure which can be done on the drive axle housing. The vendor, Rockwell International, will permit repairing drive axle housing assemblies by welding ONLY in the following areas:

1. Cover welds.
2. Snorkel welds.
3. Housing seam welds between the suspension attaching brackets.

⚠ CAUTION ⚠

Welding can be used when the crack or damaged area is within the old weld material. Replace the axle housing if the crack extends into the metal next to the old weld. A housing that has damage in the seam weld or cover weld because of overload conditions can be repaired. A repaired housing must be used in correct applications.

⚠ WARNING ⚠

Using wrong welding procedures or welding at locations other than the three areas permitted by Rockwell will make the heat-treated component weak. A weak component will cause poor or unsafe operation of the axle and early failure. The following procedure must be used.

WELDING PROCEDURE

1. Drain the lubricant from the axle assembly.

2. Remove the axle shafts and differential carrier from the axle housing.

3. Clear the damaged area inside and outside the housing. Cleaning solvent can be used.

⚠ WARNING ⚠

Be careful when using a cleaning solvent. Follow the solvent manufacturer’s instructions For safe use to prevent injury.

4. Grind the damaged weld to the base metal.

5. Warm the complete axle housing to a temperature of 80°F (27°C) or higher.

6. Before you start welding, heat the damaged area to be repaired to approximately 300°F (149°C).

7. Use a 70,000 psi tensile weld material and the correct voltage and amperage for the diameter weld rod used. Examples of weld rods that can be used are E-7018 or ER-70S-3.

CAUTION

If the E-7018 weld rod is used, the rod must be kept dry. Electrodes that are not stored in the correct sealed containers must be heated at 700°F (371°C) for one hour before welding. Wet electrodes must be dried at 180°F (82°C) for one to two hours and then heated at 700°F (371°C) for one hour before welding.

8. Fill in the Weld Gap as follows:

CAUTION

Do not connect the ground cable at any point on the axle assembly that will put a bearing between the ground cable and weld area. If a bearing is between the ground cable and weld, the bearing will be damaged because of electrical arcing. A good location to connect the ground cable is the spring mounting pad of the housing.

A. The snorkel weld must be a 0.375 inch (9.5 mm) fillet.

B. The opening in cover welds must be filled level with the old weld.

C. The opening in seam welds must be ground out to 70% of the wall thickness. The wall thickness can be measured at the carrier opening of housing.

D. Clean the new weld area. Carefully remove all the rough weld material.

E. Install the differential carrier and axle shafts.

F. Fill the axle assembly with the correct amount of lubricant. See Section 10 (Lubrication) of this manual.

NOTE: To weld brackets or other components to the axle housing, use the procedure in Rockwell Technical Service Aid, TSA-2-9S.

REPLACING GASKET AND SEALS

At the time of axle or carrier repair, all gaskets, oil seals or grease seals should be replaced.

Silicone gasket material is used at mating surfaces of the carrier housing and the axle housing. When carrier assembly is being re-installed in the axle:

1. Remove all old gasket material from both surfaces (Figure 35).

2. Clean the surfaces where silicone gasket material will be applied. Remove all oil, grease, dirt and moisture.

3. Dry both surfaces.

4. Apply a 1/8-inch-diameter continuous bead of the silicone gasket material around one surface. Also apply the gasket material around the edge of all fastener holes in that surface (Figure 35).

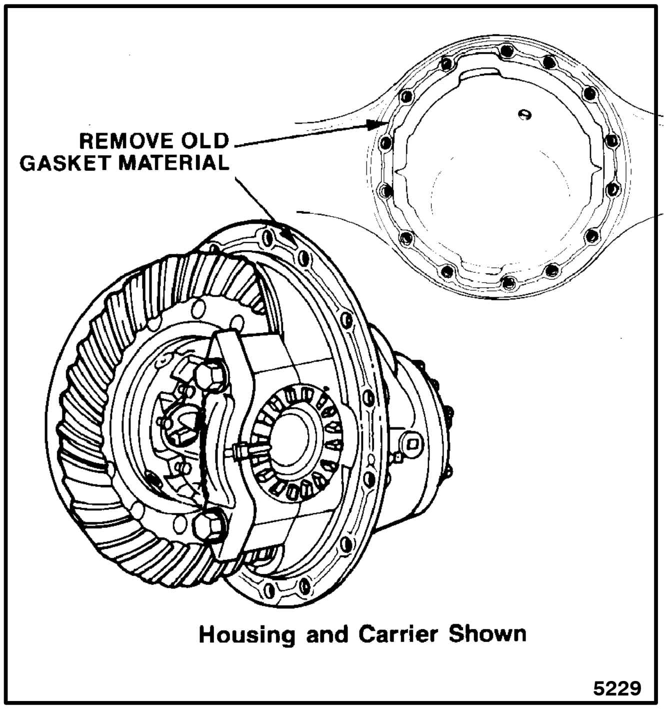


Figure 35. Replacing Silicone Gasket

CAUTION

The amount of silicone gasket material applied must not exceed a 1/8-inch-diameter bead. Too much gasket material can block lubrication passages.

5. Assemble the components immediately to permit the silicone gasket material to compress evenly between the parts. Tighten fasteners to the required torque value for that size fastener. See Torque Chart later in this section.

6. Wait 20 minutes before the assembly is filled with lubricant.

NOTE: The following silicone gasket products can be used.

a. Dow Corning Silicone Rubber Sealant, No. 732 Black.

b. General Electric No. RTV-1473 Black.

WARNING

Small amounts of acid vapor are present when applying silicone gasket material. For this reason, be sure there is good ventilation in the work area. If the silicone gasket material gets in the eyes, flush the eyes with water for 15 minutes. Have the eyes checked by a doctor.

APPLICATION OF ADHESIVE IN BEARING BORES FOR THE DIFFERENTIAL

A special adhesive (Rockwell part number 2297-T-4108) is used in the bearing bores for the differential. Apply as follows:

1. Clean oil and dirt from outer diameters of bearing cups and bearing bores in the carrier and bearing caps. There is no special cleaning required.

2. Apply axle lubricant to the bearing cones and the inner diameters of the bearing cups of the main differential. Do not get oil on the outer diameter of the bearing cup and do not permit oil to drip on the bearing bores.

3. Apply a single continuous bead of the adhesive to the bearing bores in the carrier and bearing caps. Apply the adhesive 360 degrees around the smooth, ground surfaces only. Do not put adhesive on threaded areas (Figure 36).

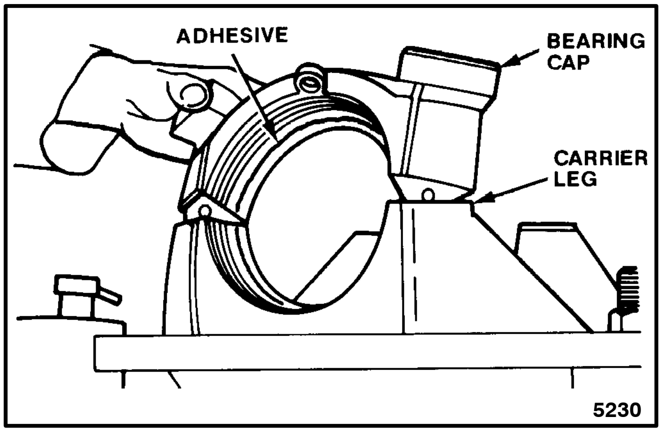


Figure 36. Applying Adhesive to Bearing Bore

NOTE: The Rockwell adhesive will become hard (dry) in approximately two hours. The following two steps of the procedure must be done in two hours from the time the adhesive was applied. If two hours have passed since application, clean the parts again and apply new adhesive.

4. Install the main differential assembly, bearing cups and bearing caps into the carrier. Use the normal procedure given later in this section.

5. Adjust preload of the differential bearings, backlash and tooth contact patterns of the gear set as required using the normal procedures given later in this section.

CHECKING FOR MATCHED RING GEAR AND DRIVE PINION SET

Before a new gear set is installed in the carrier, check the gear set for correct marks to make sure the gears are a matched set (Figure 37).

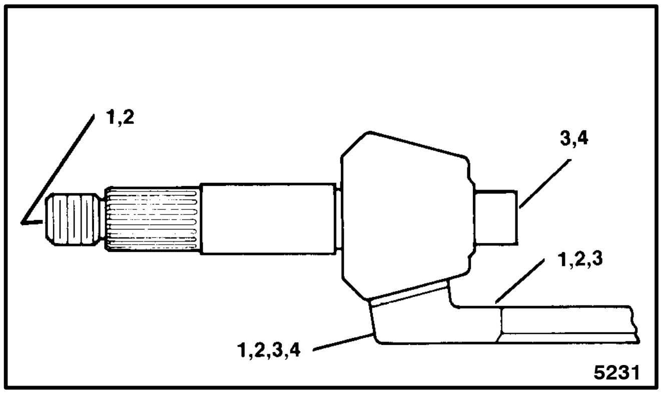


Figure 37. Location of Gear Set Marks

NOTE: The location of the marks as shown in and the numbers in the figure correspond to the following item numbers.

1. ***Part Number***

A. Examples of gear set part numbers: Ring gear, 36786; drive pinion, 36787.

B. Location on Drive Pinion: End at threads.

C. Location on Ring Gear: Front face or outer diameter.

2. ***Tooth Combination Number***

A. Example of a tooth combination number: 5-37.

NOTE: A 5-37 gear set has a 5-tooth drive pinion and a 37-tooth ring gear.

B. Location on Drive Pinion: End at threads.

C. Location on Ring Gear: Front face or outer diameter.

3. ***Gear Set Match Number*** - Rockwell drive pinions and ring gears are available only as matched sets. Both gears of a set have a match number.

A. Example of a gear set match number: M29.

NOTE: A gear set match number has any combination of a number or letter and number.

B. Location on Drive Pinion: End of gear head.

C. Location on Ring Gear: Front face or outer diameter.

4. ***Pinion Cone Variation Number***

NOTE: The pinion cone variation number is not used when checking for a matched gear set. The number is used when adjusting the depth of the pinion in the carrier. See the procedure for adjusting the shim pack thickness under the pinion cage in reassembly procedure later in this section.

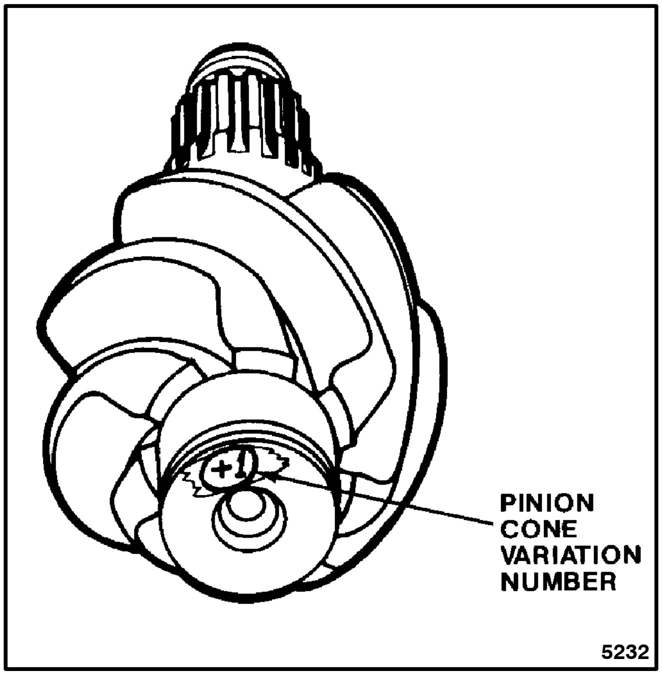


Figure 38. Location of Pinion Cone Variation Number

A. Examples of pinion cone variation numbers: PC+3, PC-5, +2, -1, +0.01 mm or -0.02 mm (Figure 38).

B. Location on Gear Set: End of pinion gear head or outer diameter of ring gear.

Yoke Installation on Interference Fit Splines

⚠ CAUTION ⚠

Do not install tight fit yokes on shafts using a hammer or mallet. A hammer or mallet will damage the yoke.

1. Apply axle lubricant on the yoke seal.
2. Check all surfaces of the yoke hub for damage. If necessary, polish the hub with an india stone, emery cloth or crocus cloth.
3. Install the pilot shaft on the input shaft of the assembly (Figure 39).
4. Slide the yoke over the pilot shaft. Align the yoke splines with the shaft splines.
5. Put the collar on the pilot shaft and slide it against the yoke.
6. Install the nut on the pilot shaft and against the collar. Tighten the nut against collar until the yoke is completely in position on the shaft. Sometimes a torque value of 200 ft-lbs on the nut is required to install the yoke correctly.

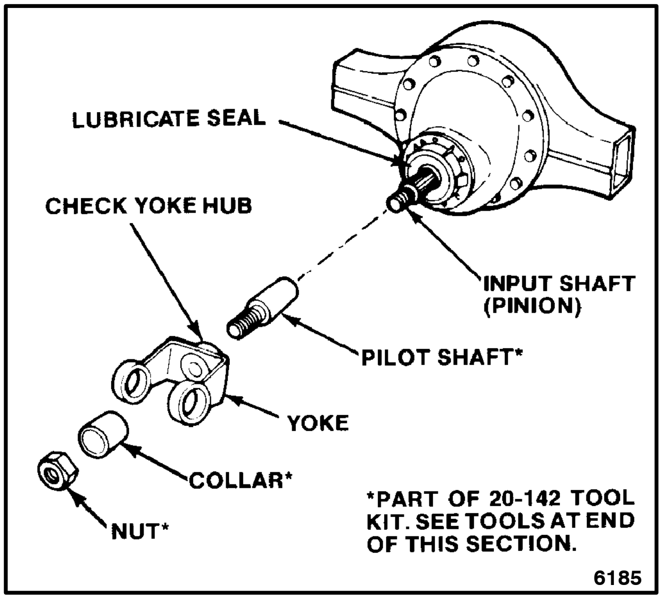


Figure 39. Installing Yoke or Flange Using Pilot Tool

⚠ CAUTION ⚠

Do not use the assembly yoke nut for installation purposes. Use the nut that is supplied with the three-piece pilot tool.

7. Remove all parts of the pilot tool from the shaft (pilot shaft, collar and nut).
8. Install the washer (if required) and yoke nut on the shaft. Tighten the nut to minimum 800 ft-lbs (1085 N·m), maximum 1100 ft-lbs (1492 N·m).

Drive Pinion, Bearings and Bearing Cage Assembly

1. Put the bearing cage in a press (Figure 40).
2. Support the bearing cage with metal or wood blocks.
3. Press the bearing cup into the bore of bearing cage until cup is flat against bottom of bore. Use a sleeve of the correct size to install bearing cup (Figure 40).

NOTE: Use the same procedure for both bearing cups.

4. Put the drive pinion in a press, gear head (teeth) toward the bottom (Figure 41).
5. Press the inner bearing cone on the shaft of the drive pinion until the cone is flat against the gear head. Use a sleeve of the correct size against the bearing inner race.

Spigot Bearing Assembly Installation

1. Put the drive pinion in a press, gear head (teeth) toward the top (Figure 42).

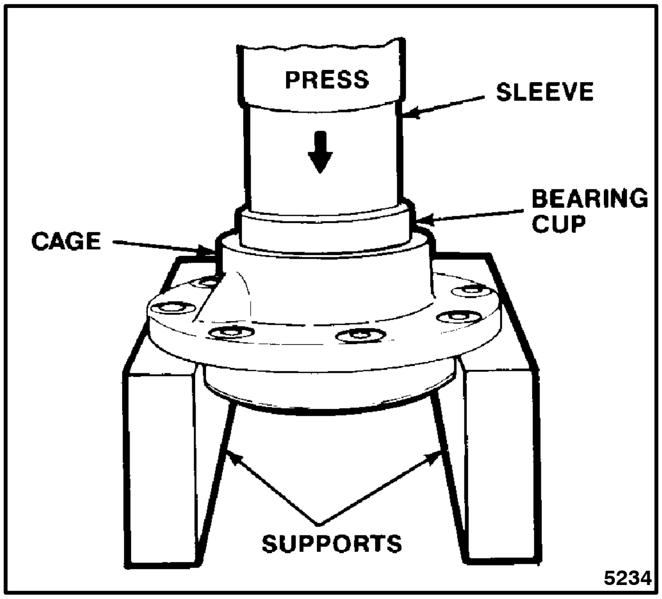

PRESS
SLEEVE
BEARING CUP
CAGE
SUPPORTS
5234

Figure 40. Pressing in Bearing Cup

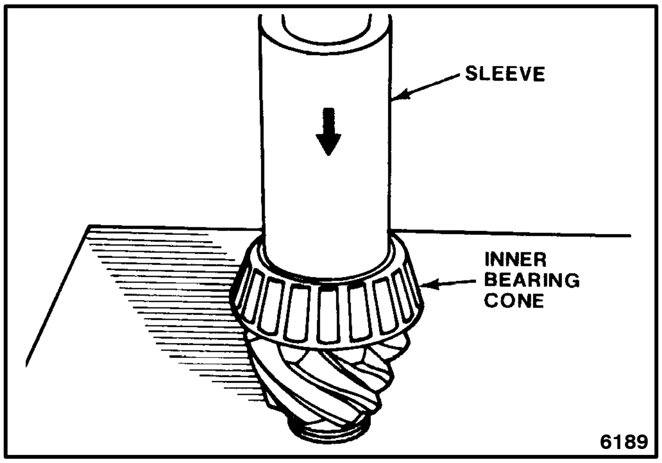

SLEEVE
INNER BEARING CONE
6189

Figure 41. Pressing on Inner Bearing Cone

2. Press the spigot bearing on the end of drive pinion until the bearing is flat against the gear head. Use a sleeve of the correct size against the bearing inner race (Figure 42).

3. Install the snap ring into groove in end of drive pinion with snap ring pliers (Figure 43).

Pinion Bearing Preload Adjustment

SPECIFICATIONS:

NEW pinion bearings; 5 - 45 in-lbs (0.56 - 5.08 N·m) torque.

USED pinion bearings in good condition; 10 - 30 in-lbs (1.13 - 3.39 N·m) torque.

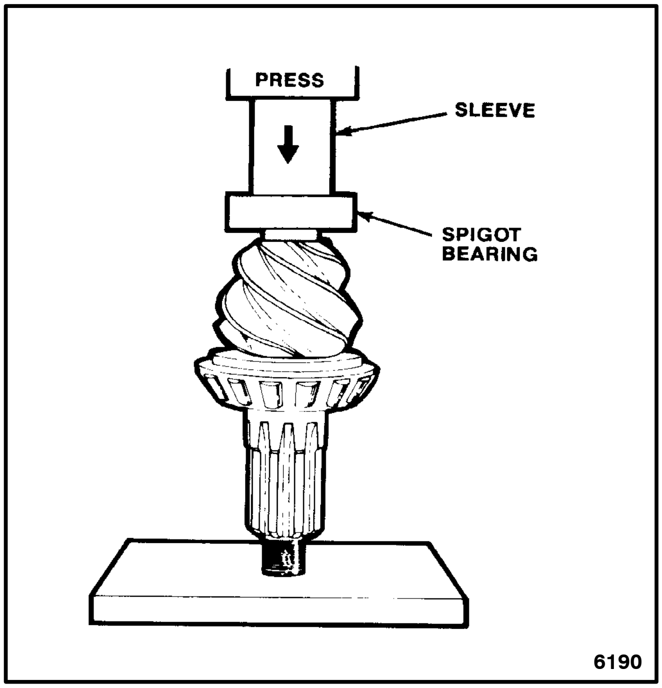

PRESS
SLEEVE
SPIGOT BEARING
6190

Figure 42. Pressing on Spigot Bearing

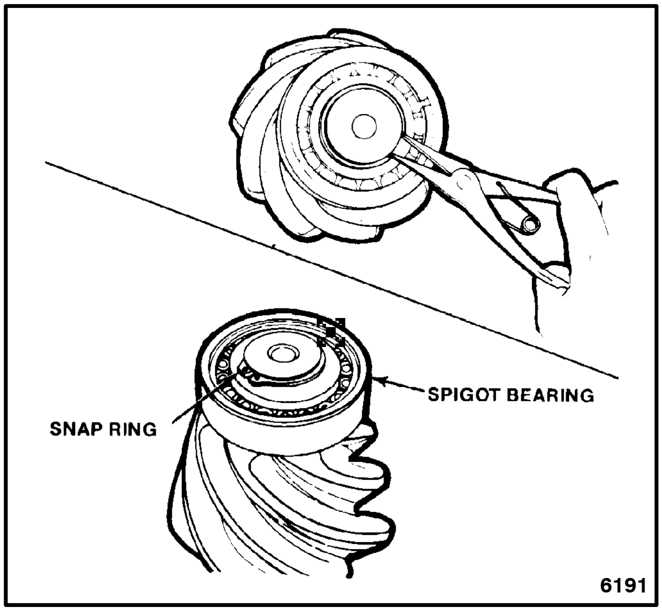

SPIGOT BEARING
SNAP RING
6191

Figure 43. Installing Snap Ring

PRESS METHOD

NOTE: If a press is not available, or the press does not have a pressure gauge, use the flange method to adjust preload. See later page.

1. Put the drive pinion and cage assembly in a press, gear head (teeth) toward the bottom.

2. Install a sleeve of the correct size against the inner race of the outer bearing (Figure 44).

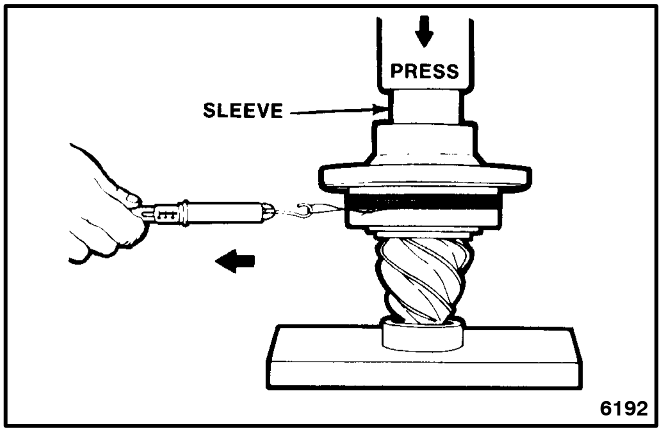


Figure 44. Checking Pinion Bearing Preload

3. Apply and hold 54,000 lbs. (24,494 kg) pressure to the pinion bearings. As pressure is applied, rotate the bearing cage several times so that bearings make normal contact.

4. While pressure is held against the assembly, wind a cord around the bearing cage several times.

5. Attach a spring scale to the end of the cord.

6. Pull the cord with scale on a horizontal line. As the bearing cage rotates, read the value indicated on scale. Make a note of reading (Figure 44).

NOTE: Do not read starting torque. Read only the torque value after the cage starts to rotate. Starting torque will give a false reading.

7. Measure the diameter of bearing cage where the cord was wound. Measure in inches or centimeters (Figure 45).

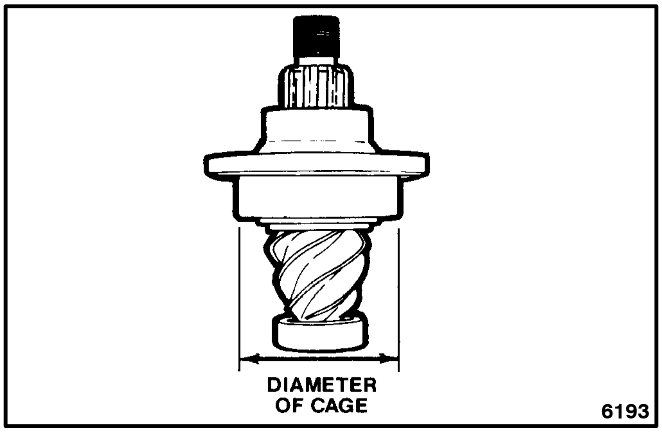


Figure 45. Measuring Diameter Of Cage

8. Divide the dimension in half to get the radius. Make a note of radius dimension.

9. Use the following procedure to calculate the bearing preload (torque).

Pounds pulled x Radius (inches) +
inch-pounds preload 0.113 + N·m preload
OR
Kilograms pulled x Radius (centimeters) +
kg-cm preload 0.098 + Nm preload

Examples:
Reading from spring scale + 7.5 pounds (3.4 kg)
Diameter of bearing + 6.62 inches (16.8 cm)
Radius of bearing cage + 3.31 inches (8.4 cm)

7.5 lb. x 3.31 in. + 24.8 in-lbs preload x 0.113
+ 2.8 N·m preload

OR
3.4 kg x 8.4 cm + 28.6 kg-cm preload x 0.098
+ 2.8 N·m preload

10. If the preload (torque) of pinion bearings is not within specifications, do the following procedure, then repeat steps 1 through 9. To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

11. Check the bearing preload with the drive pinion and cage assembly installed in the carrier. Follow the procedures to adjust preload of pinion bearings, yoke method.

YOKE METHOD

1. Install the input yoke nut and washer on the drive pinion. The yoke must be against the outer bearing.

NOTE: If the fit between the yoke splines and drive pinion splines is tight, use a press to install the yoke (Figure 46). If a press is not available, use the three-piece pilot tool for installation. See the procedure in earlier pages of this section.

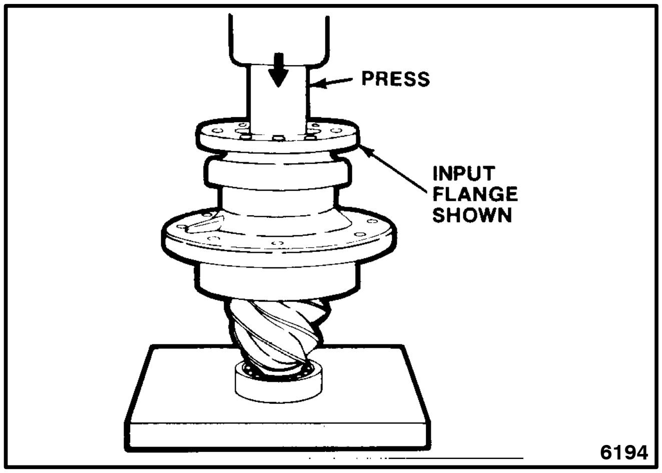


Figure 46. Pressing on Yoke

⚠ CAUTION ⚠

Do not install tight fit yokes on shafts using a hammer or mallet. A hammer or mallet will damage the yoke.

2. Temporarily install the drive pinion and cage assembly in the carrier. Do not install shims under the bearing cage (Figure 47).

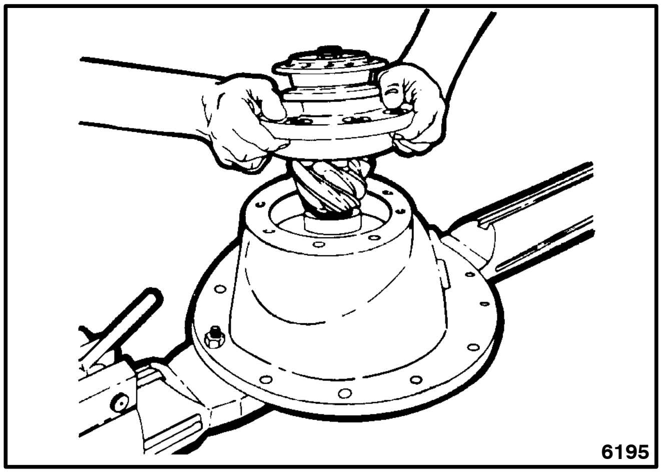


Figure 47. Placing Pinion and Cage Assembly in Carrier

3. Install the bearing cage to carrier capscrews. Washers are not required at this time. Tighten the capscrews hand tight.

4. Fasten a yoke bar to the input yoke. The bar will hold the drive pinion in position when the nut is tightened (Figure 47).

5. Tighten the nut on drive pinion to minimum 800 ft-lbs (1.085 N·m), maximum 1,100 ft-lbs (1,492 N·m) (Figure 48).

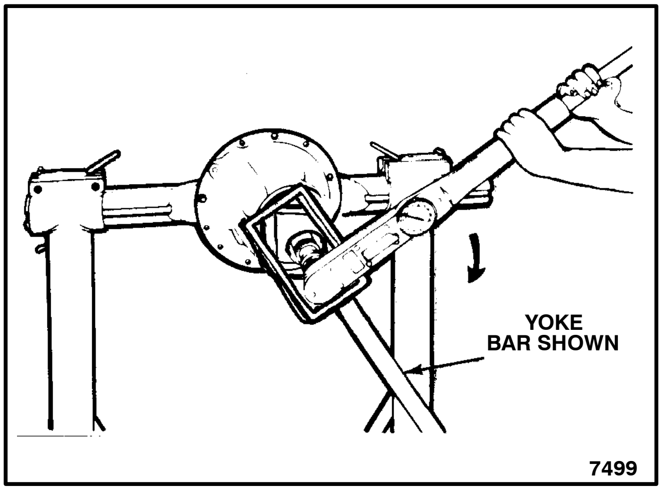


Figure 48. Torquing Drive Pinion Nut

6. Remove the yoke bar.

7. Attach a torque wrench on the drive pinion nut. Rotate the drive pinion and read the value indicated on torque wrench (Figure 49).

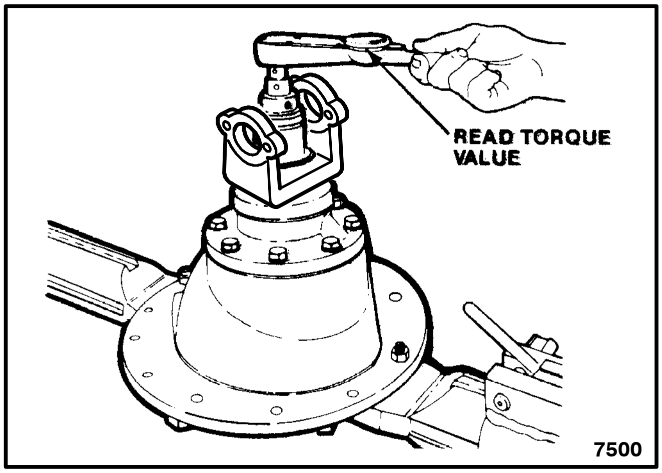


Figure 49. Reading Drive Pinion Torque

NOTE: The preload (torque) of pinion bearings can be increased or decreased by tightening or loosening the pinion nut within specifications.

8. If the preload (torque) of pinion bearings is not within specifications, remove the pinion and cage assembly from carrier. Do the following procedure, then repeat steps 1 through 7. To increase preload, install a thinner bearing spacer. To decrease preload, install a thicker bearing spacer.

After adjusting preload of pinion bearings, remove the drive pinion and bearing cage from carrier. Follow steps 1 through 4 of procedure for removing pinion and cage from carrier.

If the carrier has a cover and seal assembly over the bearing cage, install a new seal into cover as follows.

1. Apply Lubriplate or grease used for wheel bearings to the seal lips and cavities between lips.

2. Apply a sealing compound on the outer diameter of seal.

3. Put the cover in a press, large diameter toward the top.

4. Support the cover under the small diameter opening with metal or wood blocks (Figure 50).

5. Press the seal into cover until seal is flat against the bottom of bore. Use a sleeve or seal driver of the correct size that fits against the metal retainer of seal (Figure 50).

NOTE: If a press is not available, use a mallet and the sleeve or driver to install the seal (Figure 51).

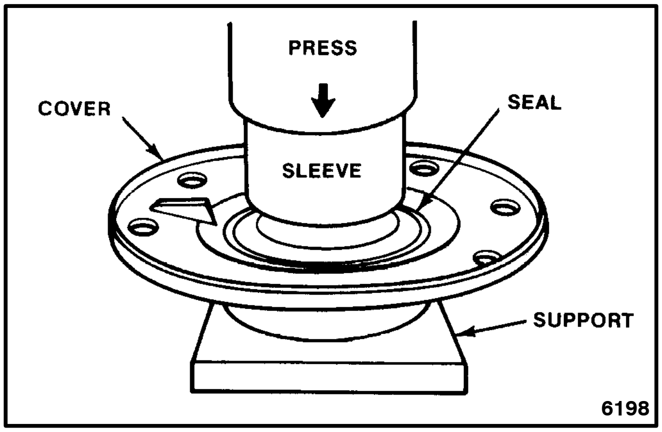

PRESS
COVER
SEAL
SLEEVE
SUPPORT
6198

Figure 50. Pressing Seal Into Cover

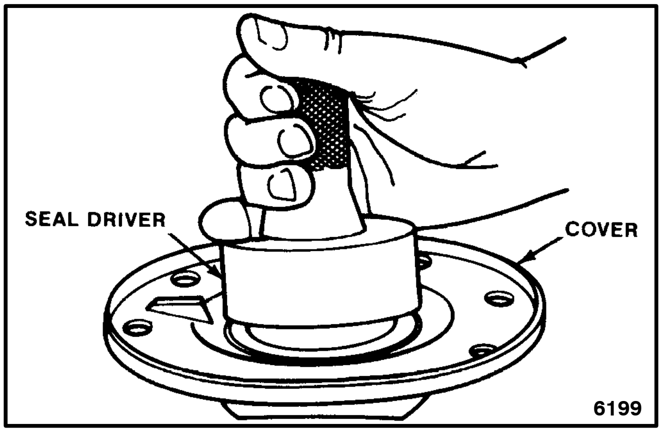

SEAL DRIVER
COVER
6199

Figure 51. Installing Seal With Driver

WARNING

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

If the pinion seal mounts directly into the bearing cage, install a new triple-lip seal as follows.

1. Apply Lubriplate or grease used for wheel bearings to the seal lips and cavities between lips (Figure 51).
2. Apply axle lubricant to seal bore in bearing cage (Figure 52).
3. Put the drive pinion and cage assembly in a press, seal bore toward the top.
4. Press the seal into bearing cage until flange of seal is flat against the top of bearing cage. Use a sleeve or seal driver of the correct size that fits against the metal flange of seal. The diameter of the sleeve or driver must be larger than the diameter of the flange (Figure 53).

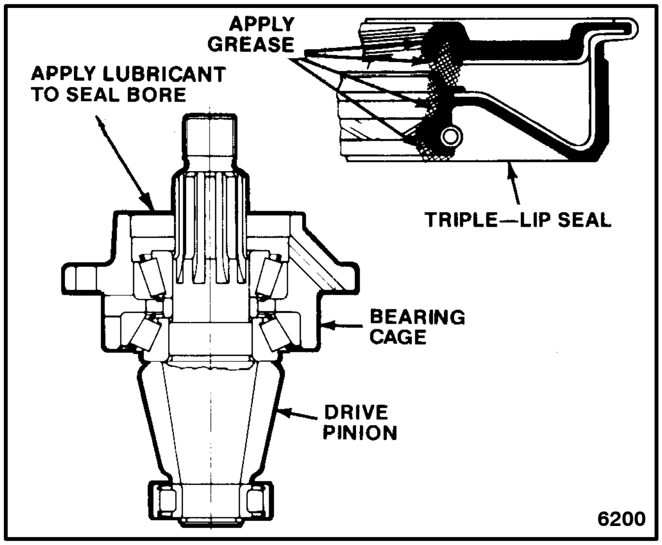

APPLY GREASE
APPLY LUBRICANT TO SEAL BORE
TRIPLE—LIP SEAL
BEARING CAGE
DRIVE PINION
6200

Figure 52. Installing Seal Into Bore

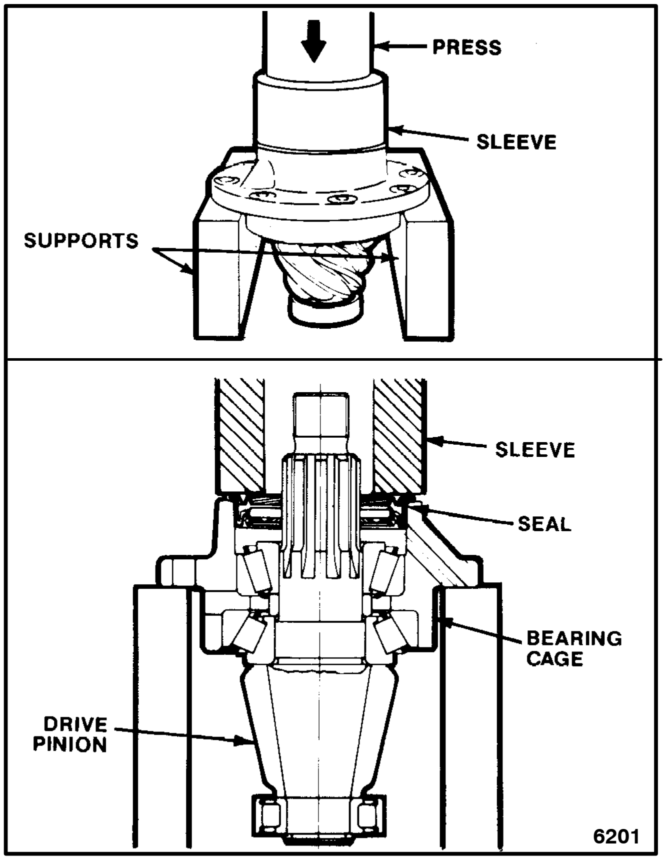

PRESS
SLEEVE
SUPPORTS
SLEEVE
SEAL
BEARING CAGE
DRIVE PINION
6201

Figure 53. Pressing In Seal

NOTE: If a press is not available, use a mallet and the sleeve or driver to install the seal (Figure 54).

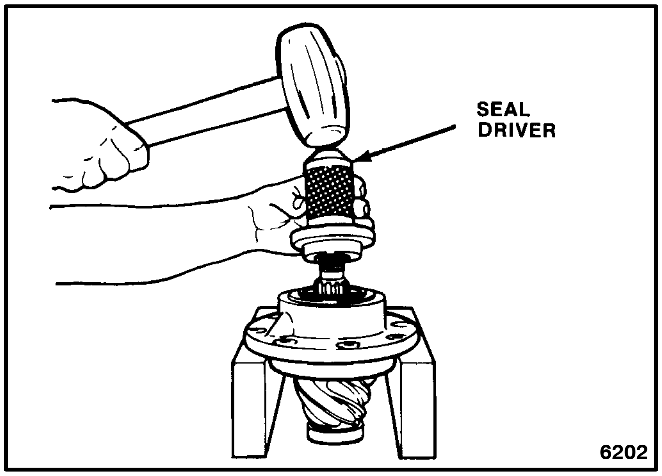


Figure 54. Installing Seal With Driver

WARNING

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

5. After the triple-lip seal is installed, a gap of approximately 0.015 - 0.030 inch (0.38 - 0.76 mm) between the flange and bearing cage is normal (Figure 55).

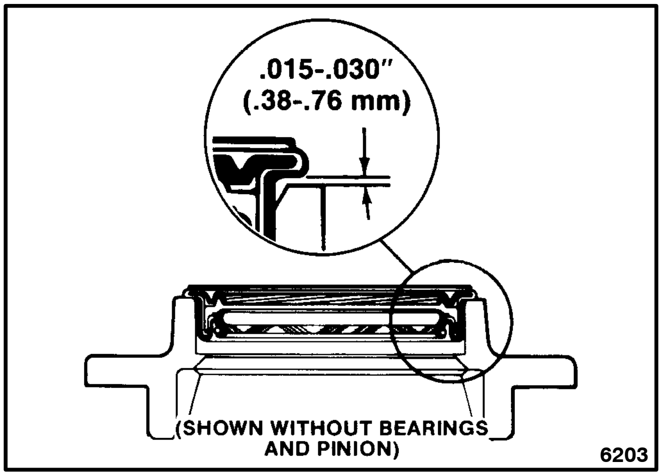


Figure 55. Checking Seal Gap

Check the gap with a feeler gauge at several points around the seal. The gap must be within 0.015 - 0.030 inch (0.38 - 0.76 mm). The difference between the largest and smallest gap measurement must not exceed 0.010-inch.

Drive Pinion, Bearing Cage and Shim Pack Installation

NOTE: If a new drive pinion and ring gear is installed, or if the depth of the drive pinion has to be adjusted, calculate the thickness of the shim pack. See the procedure to Adjust Thickness Of Shim Pack For The Pinion Cage in later pages of this section.

1. Install the correct shim pack between the bearing cage and carrier (Figure 56).

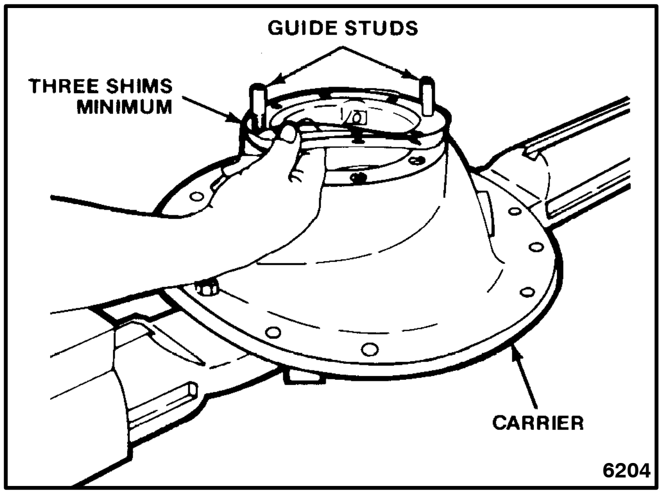


Figure 56. Installing Shims

2. Align the oil slots in the shims with oil slots in the bearing cage and carrier. Using guide studs will help align the shims (Figure 56).

NOTE: Use a minimum of three shims in a pack. If the pack is made from different thickness shims, install the thinnest shims on both sides of the pack for maximum sealing.

3. Install the drive pinion and bearing cage into the carrier. If necessary, use a rubber, plastic or leather mallet to tap the assembly into position (Figure 57).

WARNING

Wear safe eye protection. Do not hit steel parts or tools with a steel hammer. Parts or tools can break and cause injury.

4. Align the oil slots in the cover and gasket with oil slot in the bearing cage.

5. Install the bearing cage to carrier capscrews and washers. Tighten capscrews to correct torque value. See the torque chart later in this section (Figure 58).

6. Install the input yoke nut and washer on the drive pinion. The yoke must be against the outer bearing.

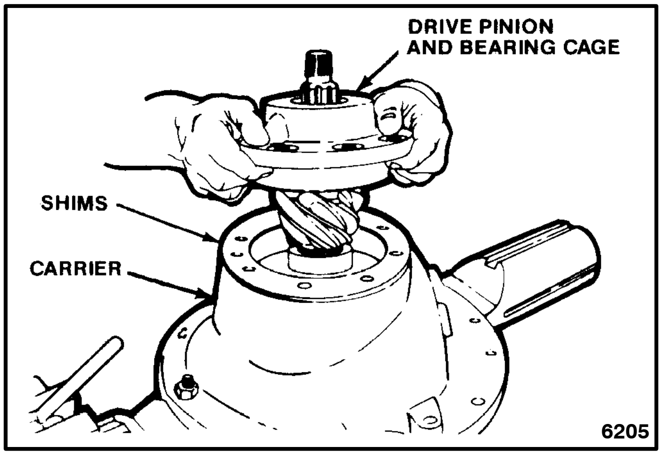


Figure 57. Installing Drive Pinion And Cage

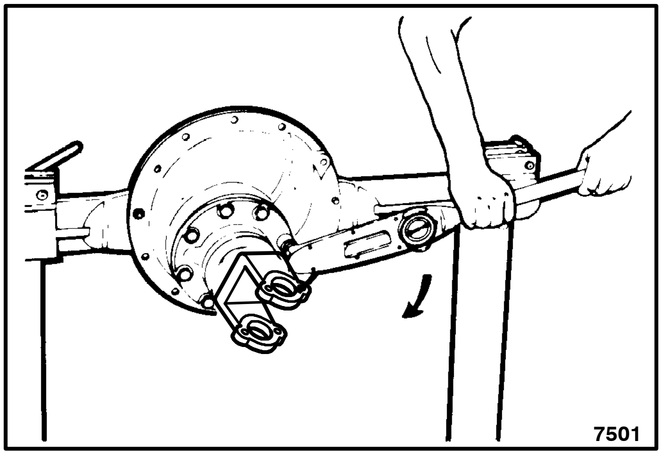


Figure 58. Torquing Cage Mounting Capscrews

NOTE: If the fit between the yoke splines and drive pinion splines is tight, use the three-piece pilot tool for installation. See the procedure in earlier pages of this section.

⚠ CAUTION ⚠

Do not install tight fit yokes on shafts using a hammer or mallet. A hammer or mallet will damage the yoke.

7. Tighten the pinion nut to minimum 800 ft-lbs (1,085 N·m), maximum 1,100 ft-lbs (1,492 N·m) (Figure 59).

PINION CAGE SHIM PACK ADJUSTMENT

NOTE: Use this procedure if a new drive pinion and ring gear set is installed, or if the depth of the drive pinion has to be adjusted (Figure 60).

1. Measure the thickness of the old shim pack that was removed from under the pinion cage with a micrometer. Record the measurement for later use (Figure 61).

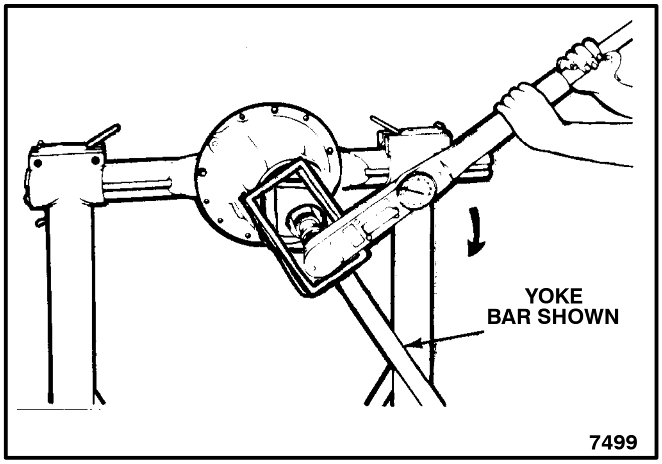


Figure 59. Torquing Yoke Nut

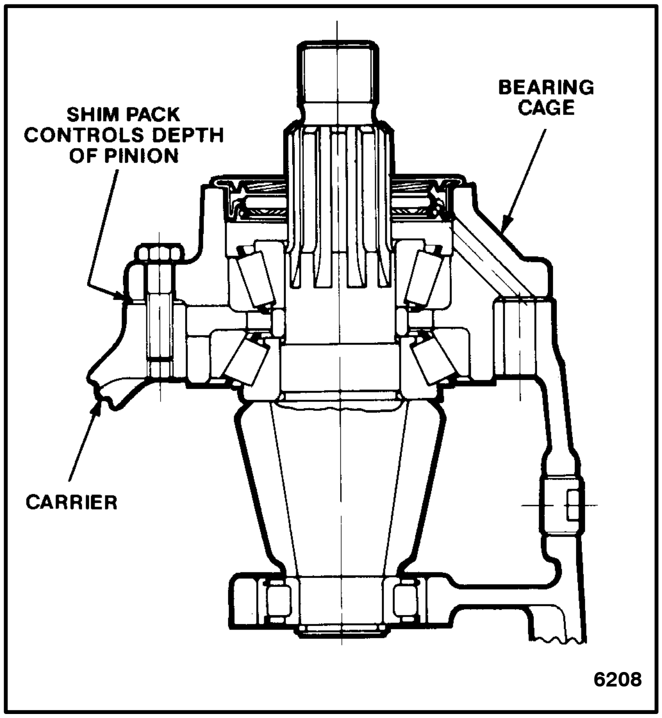


Figure 60. Shim Pack Adjustment

2. Look at the pinion cone ("PC") variation number on the old drive pinion that is being replaced. See Gear Set Information, step 4 in earlier pages of this section for examples and locations of the number. Record the number for later use.

NOTE: The pinion cone number can be either 1,000ths of an inch or 100ths of a millimeter. See the following examples.

PC+3, PC-3, +3 or -3 equal 0.003 inch.
PC+0.03, PC-0.03, +0.03 or -0.03 equal 0.03 mm.

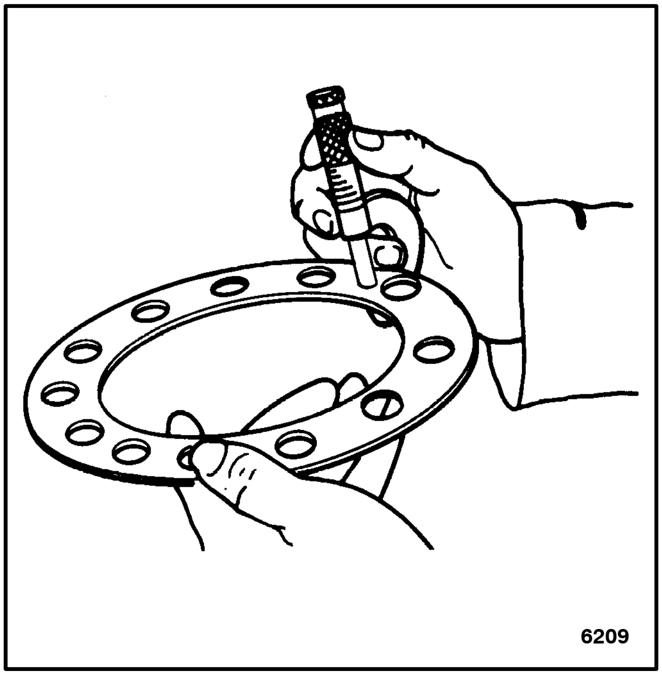


Figure 61. Measuring Thickness Of Old Shim Pack

To change inches to millimeters, multiply inches by 25.4. To change millimeters to inches, multiply millimeters by 0.03937.

3. If the old pinion cone number is a plus (+), subtract the number from the old shim pack thickness that was measured in step 2.

4. If the old pinion cone number is a minus (−), add the number to the old shim pack thickness that was measured in step 2.

NOTE: The value calculated in step 3 or 4 is the thickness of the standard shim pack, without a variation.

5. Look at the pinion cone ("PC") variation number on the new drive pinion that will be installed. Record the number for later use.

6. If the new pinion cone number is a plus (+), add the number to the standard shim pack thickness that was calculated in step 3 or 4.

7. If the new pinion cone number is a minus (−), subtract the number from the standard shim pack thickness that was calculated in step 3 or 4.

NOTE: The value calculated in step 6 or 7 is the thickness of the new shim pack that will be installed. See the example in the following chart.

Examples:		Inches	mm
1.	Old Shim Pack Thickness	.030	−.76
	Old PC Number, PC+2	−.002	−.05
	Standard Shim Pack Thickness	.028	.71
	New PC Number, PC+5	+.005	+.13
	New Shim Pack Thickness	.033	.84
2.	Old Shim Pack Thickness	.030	.76
	Old PC Number, PC−2	+.002	+.05
	Standard Shim Pack Thickness	.032	.81
	New PC Number, PC+5	+.005	+.13
	New Shim Pack Thickness	.037	.94
3.	Old Shim Pack Thickness	.030	.76
	Old PC Number, PC+2	−.002	−.05
	Standard Shim Pack Thickness	.028	.71
	New PC Number, PC−5	−.005	−.13
	New Shim Pack Thickness	.023	.58
4.	Old Shim Pack Thickness	.030	.76
	Old PC Number, PC−2	+.002	+.05
	Standard Shim Pack Thickness	.032	.81
	New PC Number, PC−5	−.005	−.13
	New Shim Pack Thickness	.027	.68

IMPORTANT: Remember that the drive pinions and ring gears must be replaced as matched sets.

8. Install the drive pinion, bearing cage and new shim pack into the carrier. See the procedure earlier in this section.

Differential and Ring Gear Assembly

CAUTION

Do not press a cold ring gear on the flange case half. A cold ring gear will damage the case half because of the tight fit. Metal particles between the parts will cause gear runout that exceeds the Rockwell specification of 0.008 inch (0.2 mm).

1. Expand the ring gear by heating the gear in a tank of water to a temperature of 160° to 180°F (71° to 82°C) for 10 - 15 minutes.

WARNING

Wear safe clothing and gloves that will protect you from injury when you touch the hot ring gear.

2. Safely lift the ring gear from the tank of water using a lifting tool.

3. Install the ring gear on the flange case half immediately after the gear is heated. If the ring gear does not fit easily on the case half, heat the gear again. Repeat step 1.

4. Align fastener holes of the ring gear and flange case half. Rotate the ring gear as needed.

5. Install the bolts, nuts and washers that hold the ring gear to the flange case half. Install the bolts from the gear side of the assembly. The bolt heads must be against the ring gear (Figure 62).

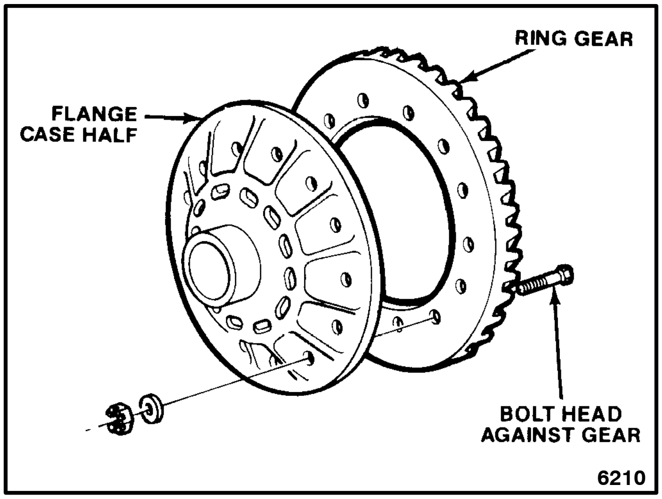


Figure 62. Installing Ring Gear Mounting Bolts

6. Tighten the bolts and nuts to the correct torque value. See the torque chart later in this section.

7. When rivets are used to hold the ring gear to the flange case half, install the rivets as follows:

⚠ CAUTION ⚠

Do not heat rivets before installation. Use only cold rivets to fasten the ring gear correctly on the flange case half.

A. Install the correct size rivets in pairs opposite each other from the case half side of the assembly. The rivet heads must be against the flange case half (Figure 63).

B. Press the rivets into position from the ring gear side of the assembly. Use a riveter machine and apply the correct amount of pressure. See following chart for rivet pressures.

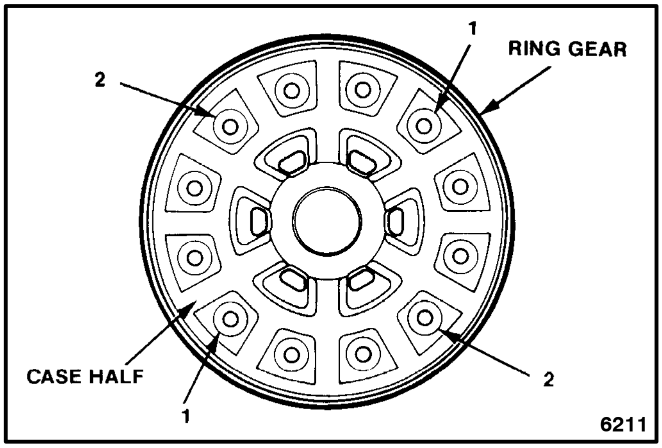


Figure 63. Installing Rivets

Diameter of Rivet Body	Press Pressure Needed to Install Rivets	
inch (mm)	pounds / tons	kilograms / metric tons
.438 (11.13)	44,000 / 22	19,958 / 20.0
.500 (12.70)	60,000 / 30	27,216 / 27.2
.563 (14.30)	72,000 / 36	32,659 / 32.7
.625 (15.88)	90,000 / 45	40,824 / 40.8

⚠ CAUTION ⚠

The pressure on rivets must be held for approximately one minute so that the rivet body will fill the hole.

C. After the rivets are installed, check for gaps between the back surface of the ring gear and the case flange. Use a 0.003 inch (0.08 mm) feeler gauge and check at four points around the assembly (Figure 64).

If the gauge fits more than one-half the distance between the outer diameter of the flange and the pilot diameter of the gear, remove the ring gear. See the procedure for rivet removal in earlier pages of this section and the following steps d and e. If the gap is less than 0.003 inch (0.08 mm), continue by following step 8.

D. Check the flange case half and ring gear for the problem that causes the gap. Repair or replace parts.

E. After the parts are repaired or replaced, assemble the ring gear on the flange case half. Repeat steps 1 through 6 and steps 7a through 7c of the main differential and ring gear assembly procedure.

8. Install the bearing cones on both of the case halves. Use a press and sleeve of the correct size (Figure 65).

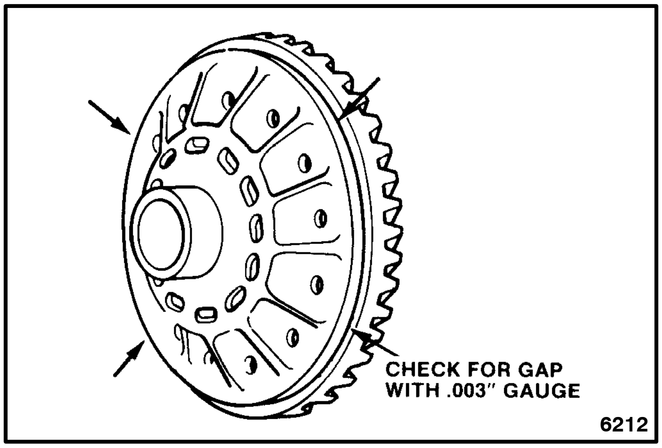

CHECK FOR GAP
WITH .003″ GAUGE
6212

Figure 64. Checking Gap

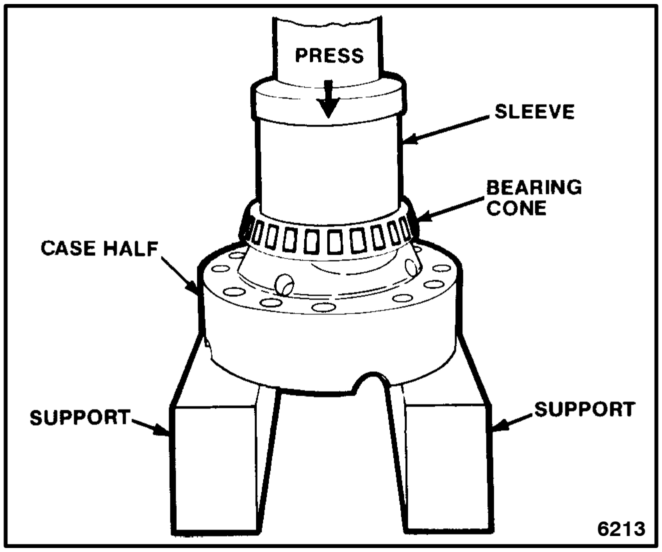

PRESS
SLEEVE
BEARING
CONE
CASE HALF
SUPPORT
SUPPORT
6213

Figure 65. Installing Bearing Cones

9. Apply axle lubricant on the inside surfaces of both case halves, spider (cross), thrust washers, side gears and differential pinions.

10. Put the flange case half on a bench, ring gear teeth toward top.

11. Install one thrust washer and side gear into the flange case half (Figure 66).

⚠ CAUTION ⚠

The side gears in some carrier models have hubs of different lengths. Install the correct length side gear into the flange case half.

12. Install the spider (cross), differential pinions and thrust washers into the flange case half (Figure 67).

13. Install the second side gear and thrust washer over spider and differential pinions (Figure 68).

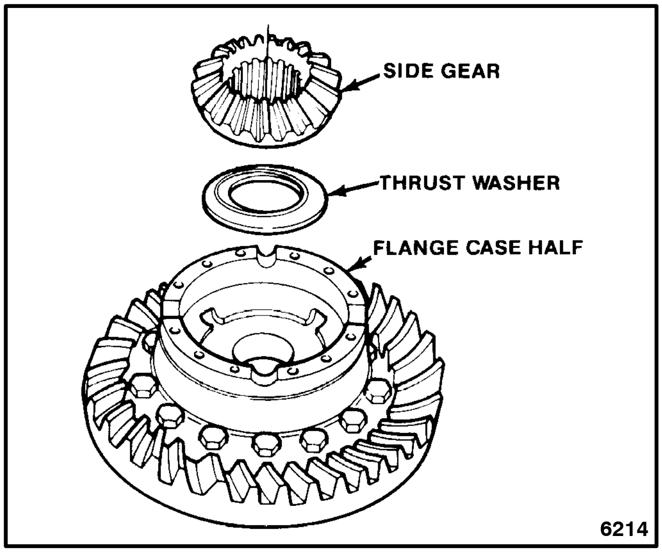

SIDE GEAR
THRUST WASHER
FLANGE CASE HALF
6214

Figure 66. Installing Thrust Washer and Side Gear

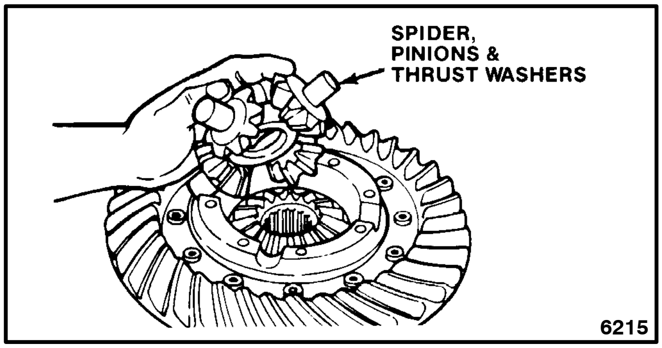

SPIDER,
PINIONS &
THRUST WASHERS
6215

Figure 67. Installing Spider, Pinions and Thrust Washers

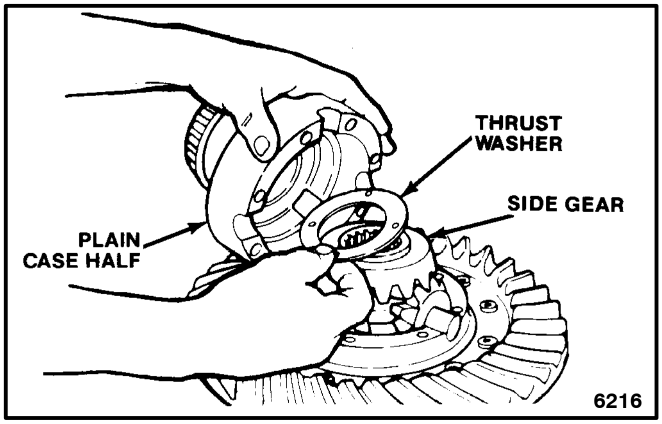

THRUST
WASHER
SIDE GEAR
PLAIN
CASE HALF
6216

Figure 68. Installing Second Side Gear and Thrust Washer

14. Put the plain half of the differential case over the flange half and gears. Rotate the plain half as needed to align the match marks (Figures 68 and 69).

15. Install Dri-Loc fasteners into the case halves. See the procedures in earlier part of this section and the following steps, a and b.

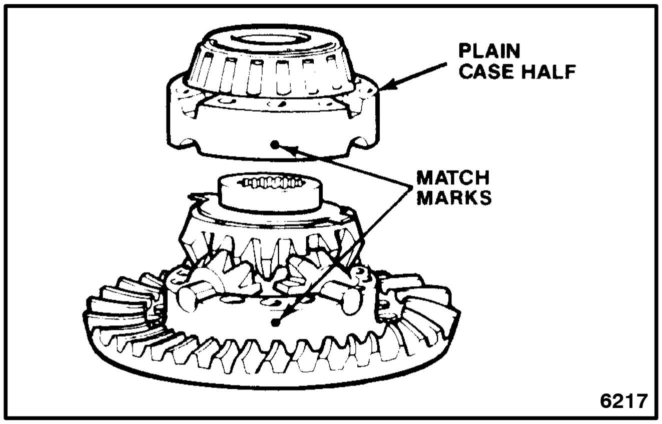


Figure 69. Aligning Match Marks

A. Install four capscrews and washers or bolts, nuts and washers into the case halves. The distance between the fasteners must be equal. Tighten the fasteners to the correct torque value in a pattern opposite each other (Figure 70). See torque chart in later pages of this section.

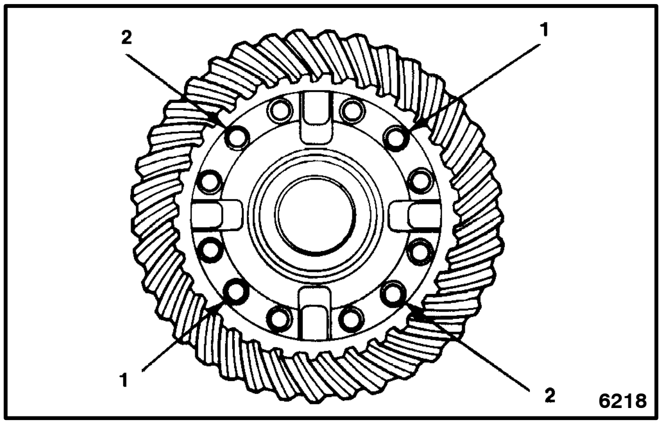


Figure 70. Installing Capscrews in Equally Spaced Pattern

B. Install the other fasteners into the case halves. Tighten the fasteners to the correct torque value. See the torque chart later in this section.

16. Check the rotating resistance of the differential gears. Use the following procedure.

ROTATING RESISTANCE CHECK OF DIFFERENTIAL GEARS

Specification:

50 ft-lbs (67.8 N·m) torque maximum applied to one side gear.

NOTE: Make a tool for checking the rotating resistance of the differential gears. The tool can be made from an axle shaft that matches the spline size of the differential side gear (Figure 71).

A. Install soft metal covers over vise jaws to protect the ring gear (Figure 72).

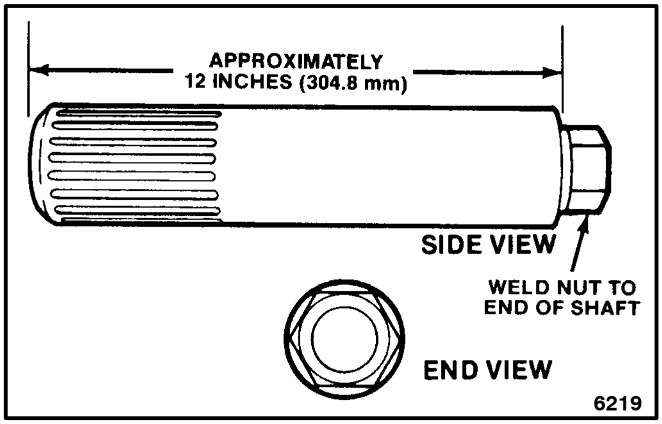


Figure 71. Rolling Resistance Check Tool

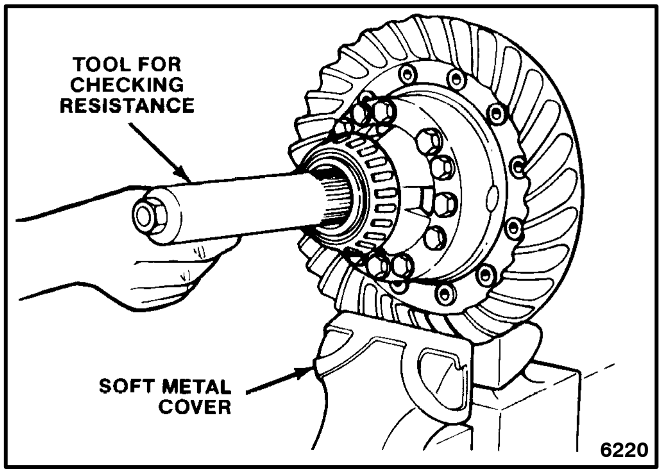


Figure 72. Installing Rolling Resistance Checking Tool

B. Put the differential and ring gear assembly in the vise.

C. Install the tool into the differential until the splines of the tool and one side gear are engaged (Figure 72).

D. Attach a torque wrench to the nut of the tool and rotate the differential gears. As the differential gears rotate, read the value indicated on the torque wrench (Figure 73).

E. If the torque value exceeds the specification, disassemble the differential gears from the case halves.

F. Check the case halves, spider, gears and thrust washers for the problem that causes the torque value to exceed the specification. Repair or replace parts.

17. After the parts are repaired or replaced, assemble the parts and repeat steps a through f.

INSTALLATION

1. Clean and dry the bearing cups and bores of the carrier legs and bearing caps.

2. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are assembled on the case halves.

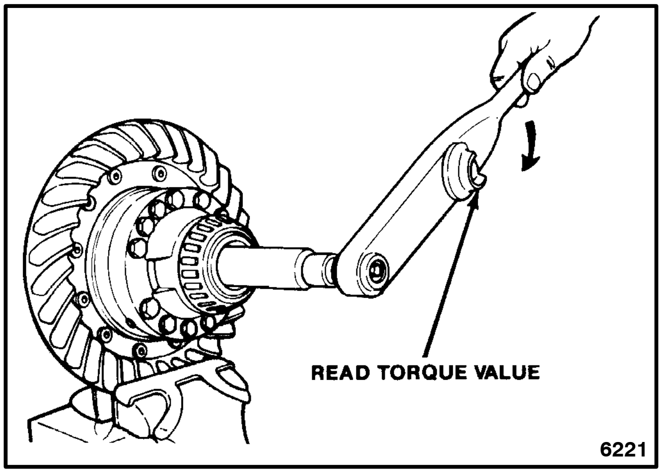


Figure 73. Reading Rolling Resistance Check

3. Apply Rockwell Adhesive in the bearing bores of the carrier legs and bearing caps. See the procedure in earlier pages of this section.

4. Install the bearing cups over the bearing cones that are assembled on the case halves (Figure 74).

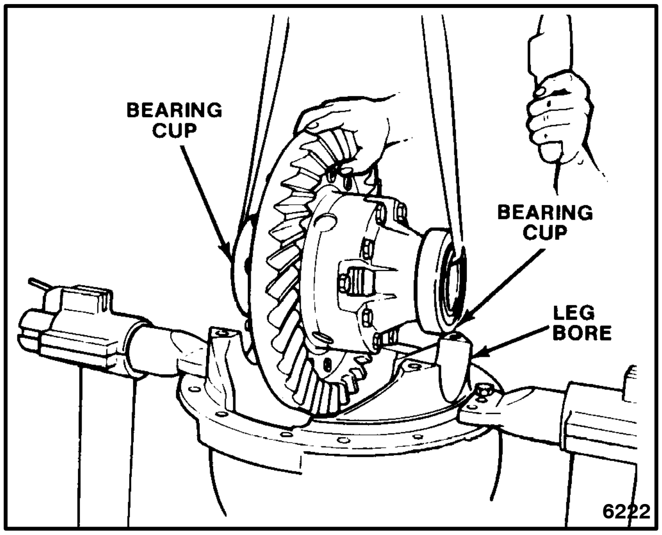


Figure 74. Installing Bearing Cups

5. Safely lift the differential and ring gear assembly and install into the carrier. The bearing cups must be flat against the bore between the carrier legs (Figure 74).

6. Install both of the bearing adjusting rings into position between the carrier legs. Turn each adjusting ring hand tight against the bearing cup (Figure 75).

7. Install the bearing caps over the bearings and adjusting rings in the correct location as marked before removal (Figure 76).

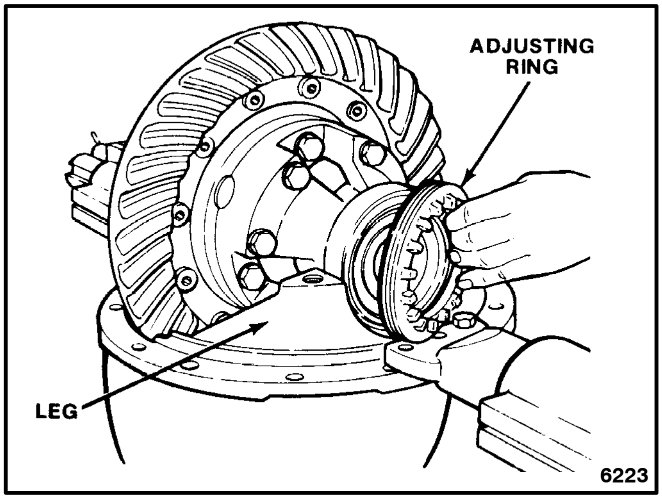


Figure 75. Installing Bearing Adjusting Rings

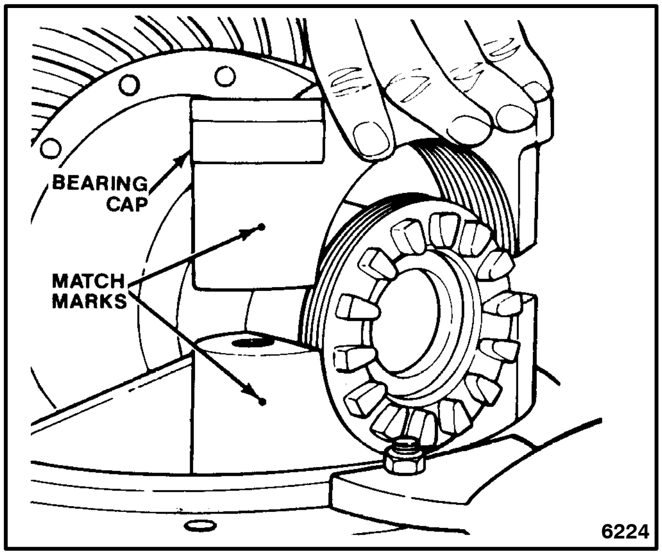


Figure 76. Installing Bearing Caps

WARNING

Wear safe eye protection. do not hit steel parts with a steel hammer. Parts can break and cause injury.

8. Hit each bearing cap into position with a light leather, plastic or rubber mallet. The caps must fit easily against the bearings, adjusting rings and carrier. Do not force the bearing caps into position.

⚠ CAUTION ⚠

If bearing caps are not installed in correct locations, the bores and threads in caps will not match the carrier. Problems assembling the caps on the carrier and damage to parts can occur. Do not force the bearing caps into position.

9. If bearing caps do not correctly fit into position, check the alignment of match marks between caps and carrier. Remove the caps and repeat steps 6 through 8.

10. Install the capscrews and washers that hold bearing caps to the carrier. Tighten the capscrews by hand four to six turns, then tighten the capscrews to the correct torque value. See the torque chart on later page of this section.

NOTE: Do not install the cotter keys, pins or lock plates that hold the bearing adjusting rings in position. Continue by adjusting the preload of differential bearings, adjust backlash of the hypoid gear and check tooth contact patterns.

Differential Bearings Preload Adjustment

Specifications:

Preload of differential bearings – 15 - 35 in-lbs (1.7 to 3.9 N·m) torque.

1. Attach a dial indicator on the mounting flange of the carrier.

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear (Figure 77).

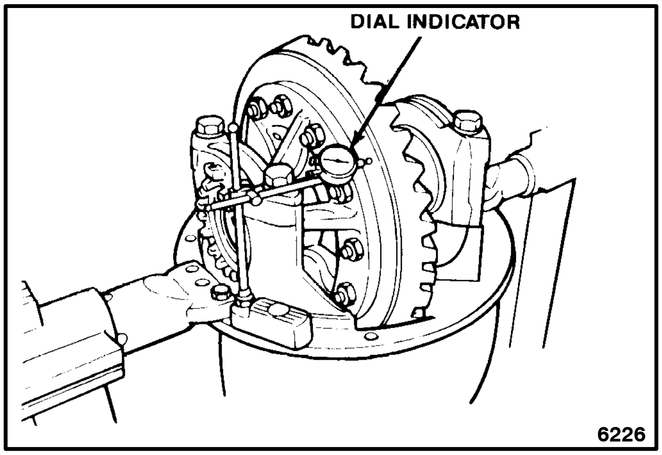


Figure 77. Positioning of Dial Indicator

⚠ CAUTION ⚠

When turning the adjusting rings, always use a tool that engages two or more opposite notches in the ring. A "T" bar wrench can be used for this purpose. If the tool does not correctly fit into the notches, damage to the lugs will occur (Figure 78).

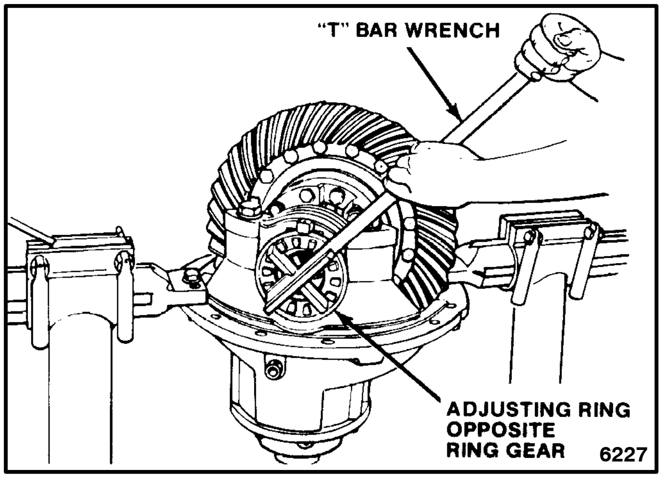


Figure 78. Loosening Bearing Adjusting Ring

3. Loosen the bearing adjusting ring that is opposite the ring gear so that a small amount of end play shows on the dial indicator (Figure 78). Move the differential and ring gear to the left and right with pry bars while reading the dial indicator. Use the following step a or b.

A. Use two pry bars that fit between the bearing adjusting rings and ends of the differential case. The pry bars must not touch the differential bearings (Figure 79).

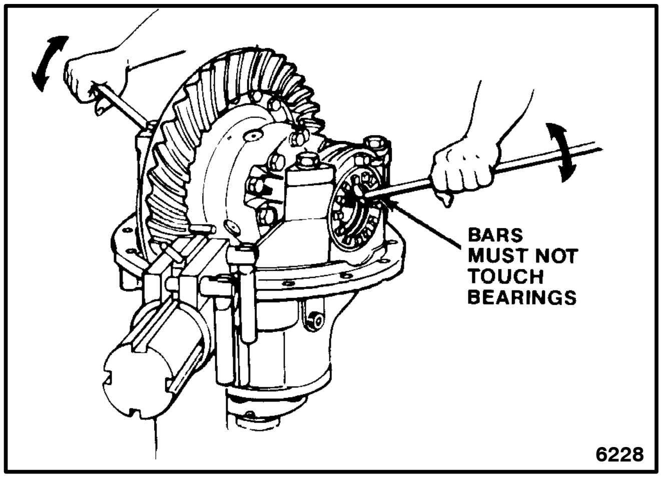


Figure 79. Placing Pry Bars at Bearing Adjusting Rings

B. Use two pry bars between the differential case or ring gear and the carrier at locations other than described in step a. The pry bars must not touch the differential bearings (Figure 80).

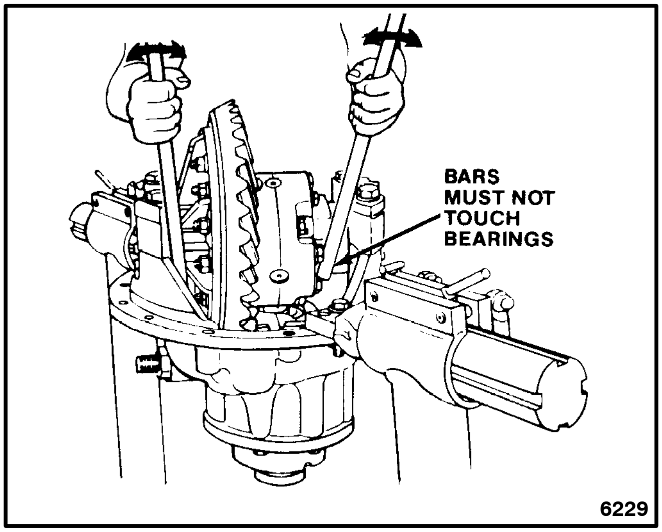


Figure 80. Placing Pry Bars (Alternate Locations)

4. Tighten the same bearing adjusting ring so that no end play shows on the dial indicator. Move the differential and ring gear to the left and right as needed. Repeat step a or b.

5. Tighten each bearing adjusting ring one notch from the zero end play measured in step 4.

6. Continue by checking runout of the ring gear.

Ring Gear Runout

1. Attach a dial indicator on the mounting flange of the carrier (Figure 81).

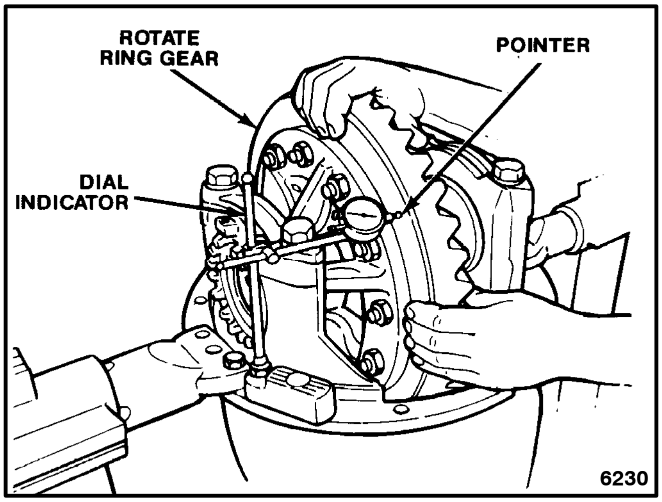


Figure 81. Checking Ring Gear Runout

2. Adjust the dial indicator so that the plunger or pointer is against the back surface of the ring gear.

3. Adjust the dial of the indicator to zero (0).

4. Rotate the differential and ring gear while you read the dial indicator. The runout of the ring gear must not exceed 0.008 inch (2.0 mm) (Figure 81). If runout of the ring gear exceeds specifications, remove the differential and ring gear assembly from the carrier. See the disassembly procedure in earlier pages of this section and the following steps 5 and 6.

5. Check the differential parts including the carrier for the problem that causes the runout of gear to exceed specifications. Repair or replace parts.

6. After the parts are repaired or replaced, install the differential and ring gear into the carrier. See the procedure in preceding pages of this section.

7. Repeat preload adjustment of differential bearings.

Ring Gear Backlash Adjustment

Measure the outer diameter of ring gear for approximate pitch diameter (Figure 82).

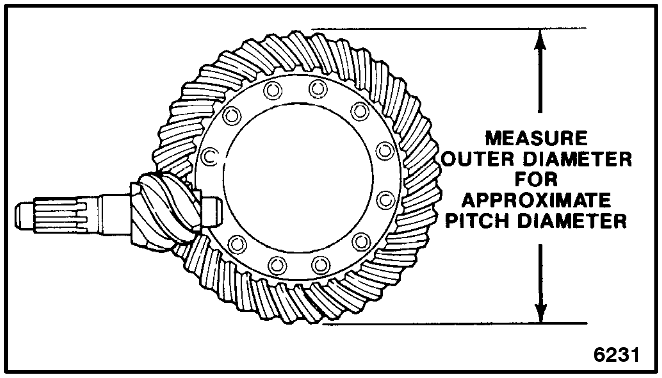


Figure 82. Determining Approximate Pitch Diameter

Specifications:

Range of backlash setting –0.008 to 0.018 inch (0.2-0.46 mm). Backlash setting for new gear sets – 0.012 inch (0.30 mm).

If the old gear set is installed, adjust the backlash to the setting that was measured before the carrier was disassembled.

If a new gear set is installed, adjust the backlash to the correct specification for new gear sets.

During the check of tooth contact patterns, the backlash can be adjusted within specification limits, if needed, to change the location of the pattern.

1. Attach a dial indicator on the mounting flange of the carrier (Figure 83).

2. Adjust the dial indicator so that the plunger or pointer is against the tooth surface (Figure 83).

3. Adjust the dial of the indicator to zero (0).

4. Hold the drive pinion in position.

5. While you read the dial indicator, rotate the differential and ring gear a small amount in both

directions, against teeth of the drive pinion. If the backlash reading is within specification, continue by checking tooth contact patterns. If the backlash reading is not within specifications, adjust backlash as needed. Continue by following steps 6 and 7.

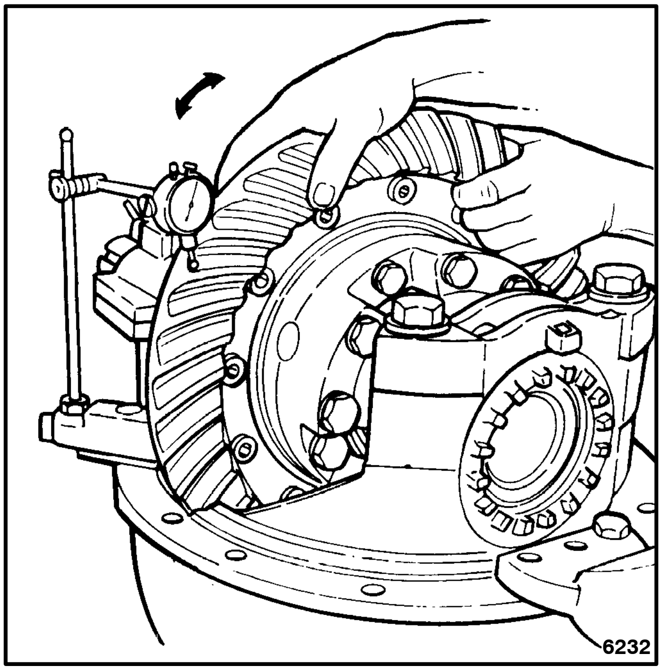


Figure 83. Attaching Dial Indicator

NOTE: Backlash is increased by moving the ring gear away from the drive pinion (Figure 84). Backlash is decreased by moving the ring gear toward the drive pinion (Figure 85).

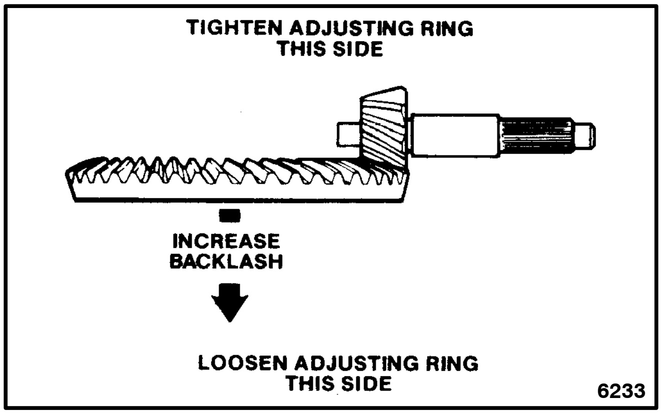


Figure 84. Adjusting For Increased Backlash

6. Loosen one bearing adjusting ring one notch, then tighten the opposite ring the same amount (see Figures 84 and 85).

NOTE: When adjusting backlash, move the ring gear only. Do not move the drive pinion.

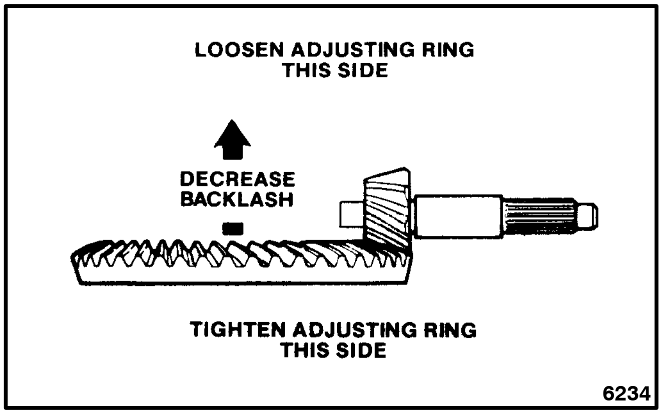


Figure 85. Adjusting for Decreased Backlash

7. Repeat steps 2 through 6 until the backlash is within specifications.

Gear Set Tooth Contact

The carrier has a conventional hypoid gear set. In the following procedures, movement of the contact pattern in the length of the tooth is indicated as toward the "heel" or "toe" of the ring gear (Figure 86).

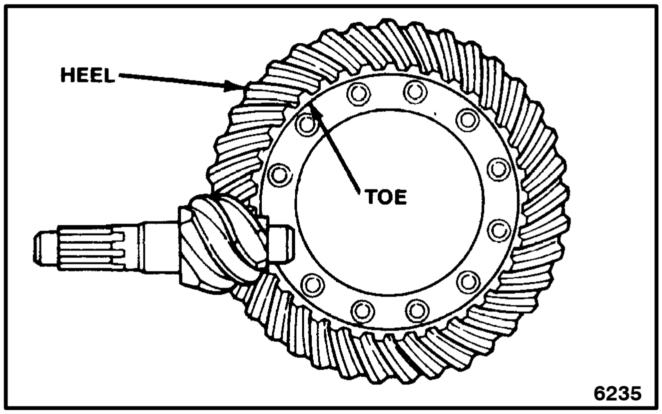


Figure 86. Hypoid Gear Heel and Toe Locations

Always check tooth contact patterns on the drive side of the gear teeth (Figure 87).

Tooth Contact Patterns Of Conventional Hypoid Gear Sets

1. Adjust the backlash of a new gear set to 0.012 inch (0.30mm). Adjust the backlash of an old gear set to the setting that was measured before the carrier was disassembled. See the procedure on previous pages.

2. Apply a marking compound, such as oiled red lead, to approximately 12 gear teeth of the ring gear. Rotate the ring gear so that the 12 gear teeth are next to the drive pinion (Figure 88).

3. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive pinion six times to get the contact patterns. Repeat if needed to get a clearer pattern.

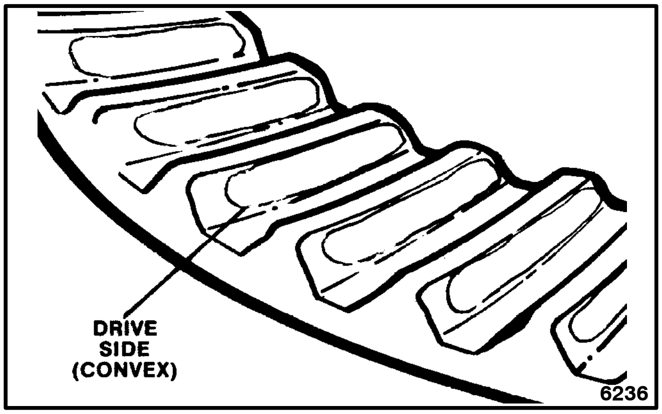


Figure 87. Checking Tooth Contact Pattern

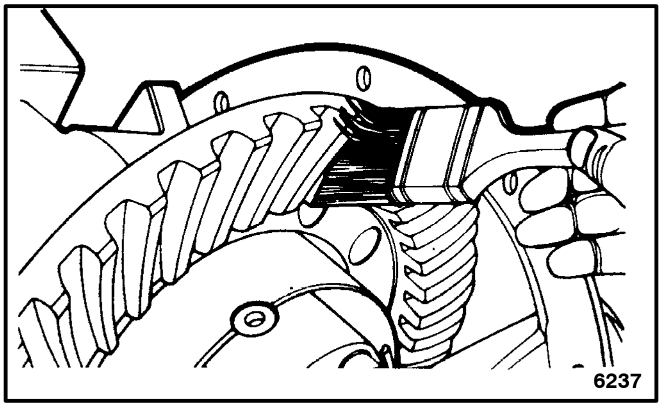


Figure 88. Applying Marking Compound

4. Look at the contact patterns on the ring gear teeth. Compare the patterns to Figures 89, 90 and 91.

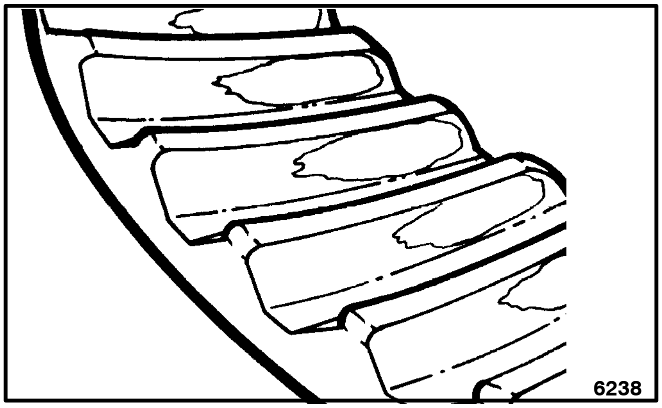


Figure 89. Good Hand Rolled Pattern

The Location of Good Hand-Rolled Contact Patterns

For new gear sets, the location of good hand-rolled tooth contact patterns will be toward the toe of the gear tooth and in the center between the top and bottom of the tooth (see Figure 89).

When the carrier is being operated, a good pattern will extend approximately the full length of the gear tooth. The top of the pattern will be near the top of the gear tooth (see Figure 92).

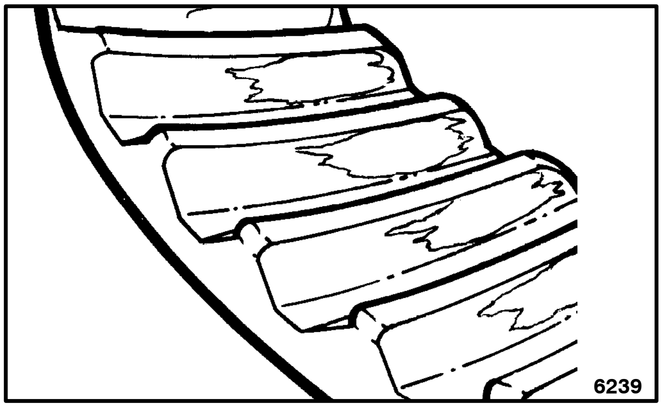


Figure 90. High Pattern

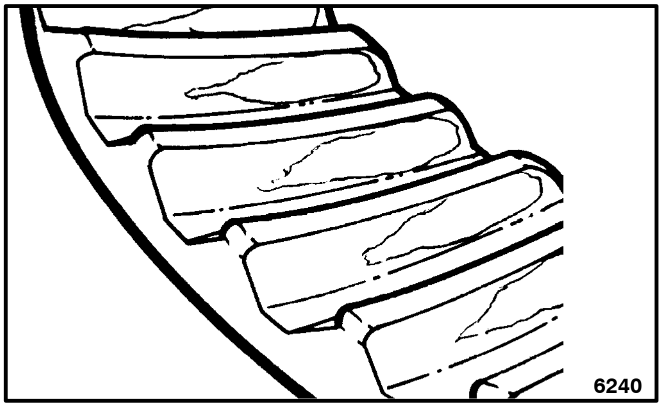


Figure 91. Low Pattern

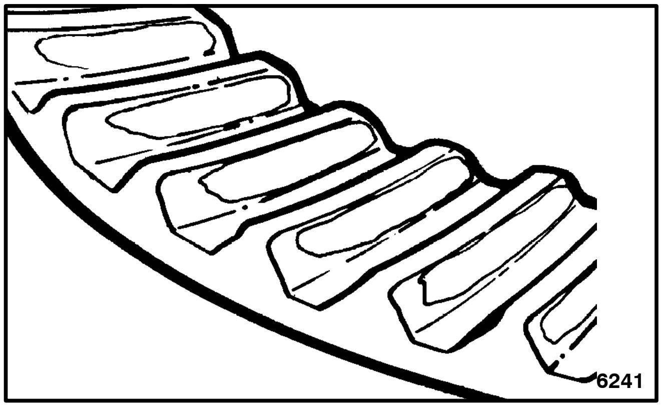


Figure 92. Good Pattern in Operation

The location of a good hand-rolled contact pattern for an old gear set must match the wear pattern in the ring gear. The contact pattern will be smaller in area than the wear pattern.

If the contact patterns require adjustment, continue by following step 5 to move the contact patterns between the top and bottom of the gear teeth. If the contact patterns are in the center of the gear teeth, continue by following step 6.

5. Change the thickness of the shim pack under bearing cage to move the contact patterns between the top and bottom of the gear teeth. Use the following procedure.

NOTE: A high contact pattern indicates that the drive pinion was not installed deep enough into the carrier. A low contact pattern indicates that the drive pinion was installed too deep in the carrier.

A. Remove the drive pinion and bearing cage from the carrier. See the procedure on previous pages.

B. To correct a high contact pattern (Figures 90 and 93), decrease the thickness of the shim pack under the bearing cage.

When the thickness of the shim pack is decreased, the drive pinion will move toward the ring gear (Figure 93). To correct a low contact pattern (Figure 91), increase the thickness of shim pack under the bearing cage. When the thickness of the shim pack is increased, the drive pinion will move away from the ring gear (Figure 94).

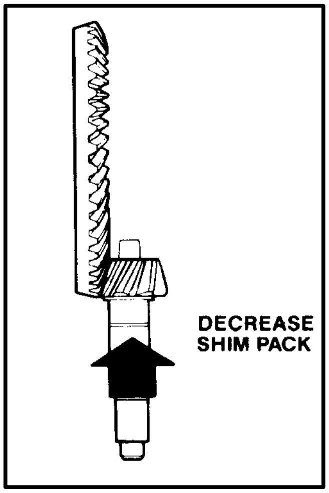


Figure 93

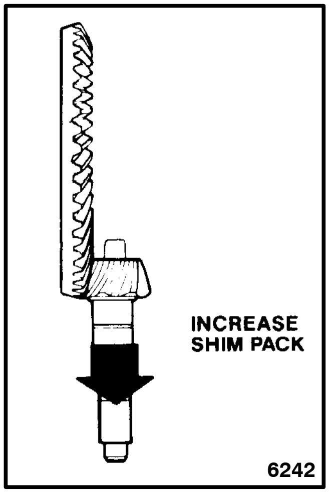


Figure 94

C. Install the drive pinion, bearing cage and shims into the carrier. See the procedure on previous pages.

D. Repeat steps 2 through 5 until the contact patterns are in the center between the top and bottom of the gear teeth.

6. Adjust backlash of the ring gear within specification range to move the contact patterns to the correct location in the length of the gear teeth. See the procedure on previous pages.

A. Decrease backlash to move the contact patterns toward the toe of the ring gear teeth (Figure 95).

B. Increase backlash to move the contact patterns toward the heel of the ring gear teeth (Figure 96).

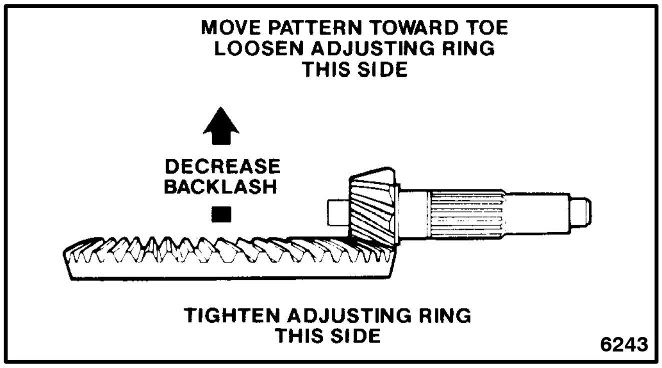


Figure 95. Moving Contact Pattern Toward Top of Ring Gear Teeth

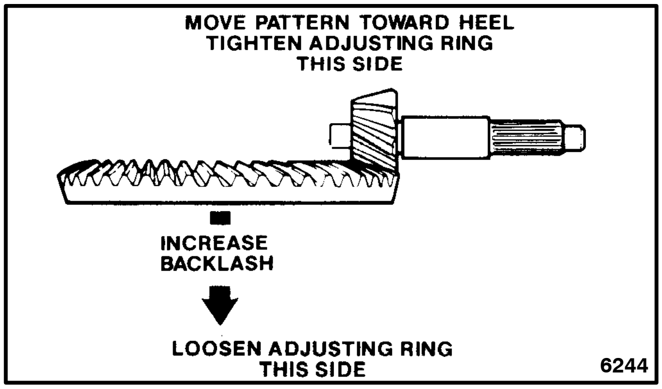


Figure 96. Moving Contact Pattern Toward Heel of Ring Gear Teeth

C. Repeat steps 2 through 4 and 6 until the contact patterns are at the correct location in the length of the gear teeth.

7. Install cotter keys, pins or lock plates that hold the two bearing adjusting rings in position. Use the following procedures.

A. Cotter Keys – Install cotter keys between lugs of the adjusting ring and through the boss of the bearing cap. Bend the two ends of the cotter key around the boss (Figure 97).

B. Pins – Install pin through boss of the bearing cap until the pin is between lugs of the adjusting ring. Use a drift and hammer to install the pin (Figure 97).

C. Lock Plates – Install lock plate on bearing cap so that the tab is between lugs of the adjusting ring. Install the two capscrews that hold the lock plate to the bearing cap. Tighten the capscrews to correct torque value. See the torque chart later in this section (Figure 97).

Thrust Screw Installation and Adjustment

Specification:

Clearance between thrust screw and ring gear, 0.025 - 0.045 inch (0.65 - 1.14 mm). Loosen the thrust screw ½ turn, 180 degrees.

1. Install the jamnut on the thrust screw, one half the distance between both ends (Figure 98).

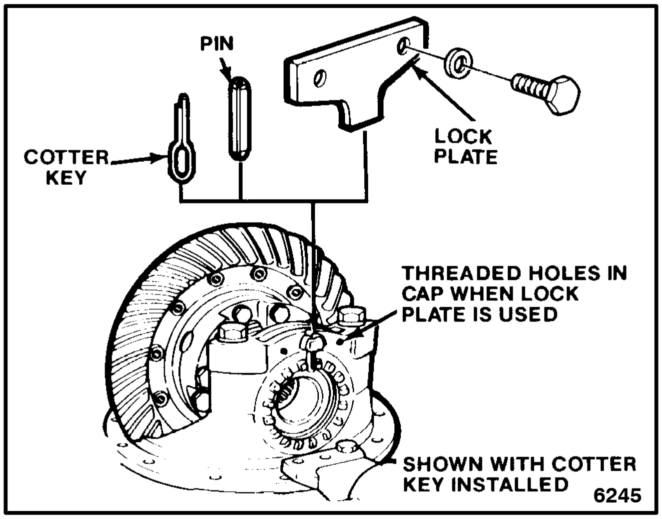

PIN
LOCK PLATE
COTTER KEY
THREADED HOLES IN CAP WHEN LOCK PLATE IS USED
SHOWN WITH COTTER KEY INSTALLED
6245

Figure 97. Fastening Bearing Adjusting Rings

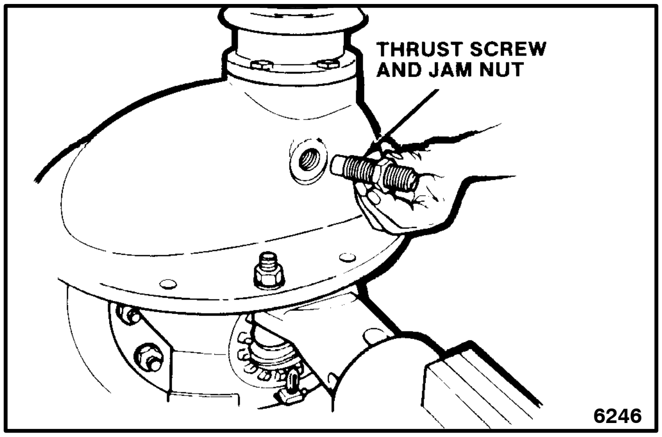

THRUST SCREW AND JAM NUT
6246

Figure 98. Installing Thrust Screw

2. Install the thrust screw into the carrier until the screw stops against the ring gear (Figure 98).

3. Loosen the thrust screw ½ turn, 180 degrees (Figure 99).

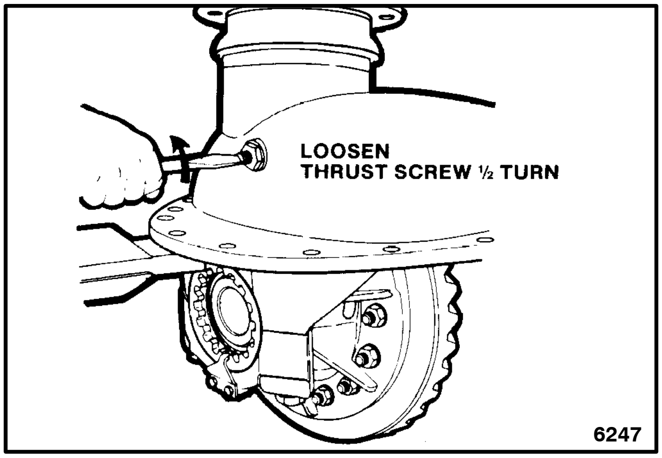

LOOSEN THRUST SCREW ½ TURN
6247

Figure 99. Adjusting Thrust Screw

4. Tighten the jamnut to the correct torque value against the carrier (Figure 100). See the torque chart later in this section.

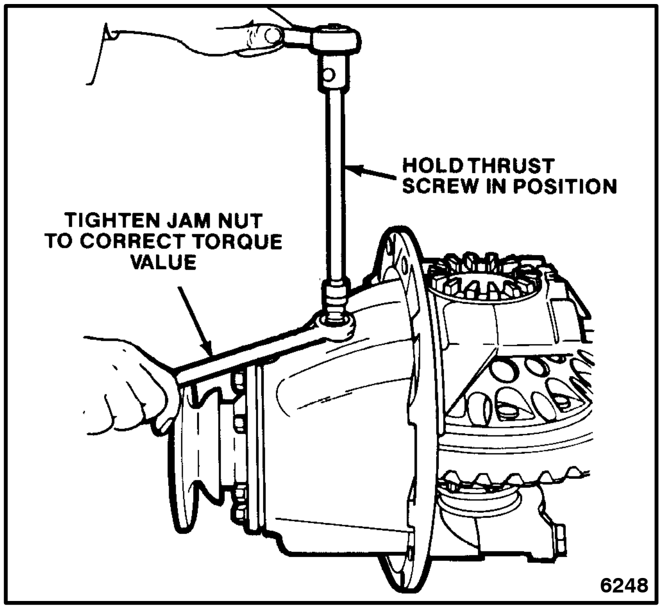

HOLD THRUST SCREW IN POSITION
TIGHTEN JAM NUT TO CORRECT TORQUE VALUE
6248

Figure 100. Torquing Jamnut on Thrust Screw

Differential Carrier Installation

⚠ **WARNING** ⚠

Be careful when using cleaning solvents. Follow the solvent manufacturer's instructions for safe use to prevent injury.

1. Clean the inside of axle housing and the mounting surface where the carrier fastens. Use a cleaning solvent and rags to remove dirt. Blow dry the cleaned areas with air. Also see the procedure on cleaning axle assembly earlier in this section.

2. Inspect the axle housing for damage. Repair or replace the axle housing. See the procedure earlier in this section.

3. Check for loose studs in the mounting surface of the housing where the carrier fastens. Remove and clean the studs that are loose.

4. Apply liquid adhesive to the threaded holes and install the studs into axle housing. See the procedure outlined earlier. Tighten studs to current torque value. See the torque chart later in this section.

5. Apply silicone gasket material to the mounting surface of the housing where the carrier fastens. See the procedure earlier in this section.

6. Install the carrier into the axle housing. Use a hydraulic roller jack or a lifting tool.

⚠ CAUTION ⚠

Do not install the carriers using a hammer or mallet. A hammer or mallet will damage the carrier mounting flange and cause oil leaks.

7. Install nuts and washers or capscrews and washers in the four corner locations around the carrier and axle housing. Tighten the fasteners hand tight at this time (Figure 101).

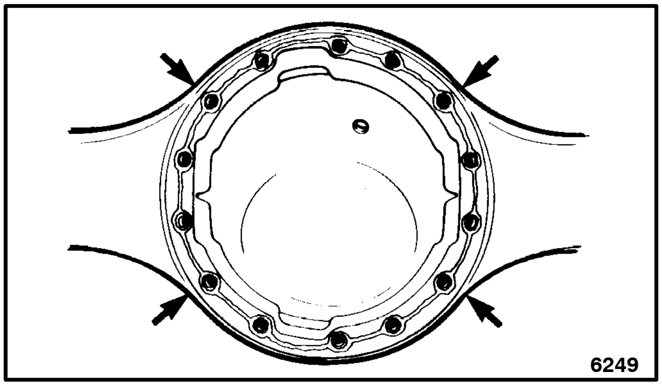


Figure 101. Installing Carrier Mounting Capscrews

8. Carefully push the carrier into position. Tighten the four fasteners two or three turns each in a pattern opposite each other (see Figure 101).

9. Repeat step 8 until the four fasteners are tightened to the correct torque value. See the torque chart later in this section.

10. Install the other fasteners and washers that hold the carrier in the axle housing. Tighten fasteners to the correct torque value. See the torque chart later in this section.

11. Connect the driveline universal joint to the pinion input yoke or flange on the carrier.

12. Install the gaskets and axle shafts into the axle housing and carrier. The gasket and flange of the axle shafts must fit flat against the wheel hub (Figure 102).

13. Install the capscrews and washers that hold the axle shaft to the wheel hub. Tighten capscrews to the correct torque value. See the torque chart later in this section.

14. If the wheel hubs have studs, install the tapered dowels at each stud and into the flange of the axle shaft. Use a punch or drift and hammer if needed.

15. Install the nuts and washers on the studs. Tighten nuts to the correct torque value. See the torque chart later in this section.

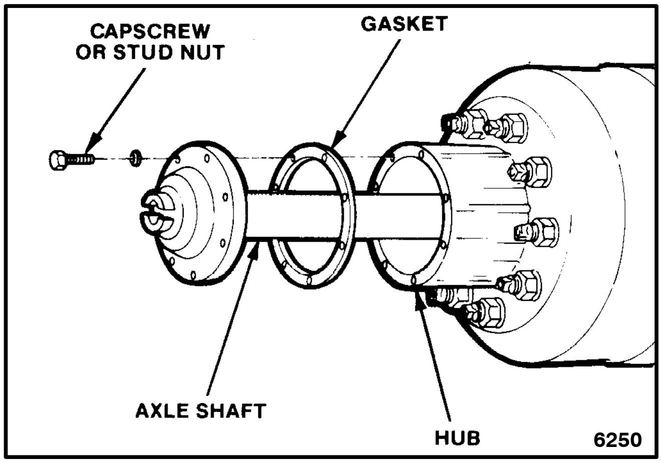


Figure 102. Installing Axle Shafts and Gaskets

DRIVE AXLE LOAD TUBE REPLACEMENT

Removal

After removing the drive axle differential assembly, the axle load tubes may be removed and new tubes installed.

An axle tube pulling and installing set, a pulling adaptor, a tube adaptor and a carrier pilot plate are required to perform this operation. Refer to the tool listing at the end of this section for the part numbers of these items. To remove the axle tube follow these steps (refer to Figure 103):

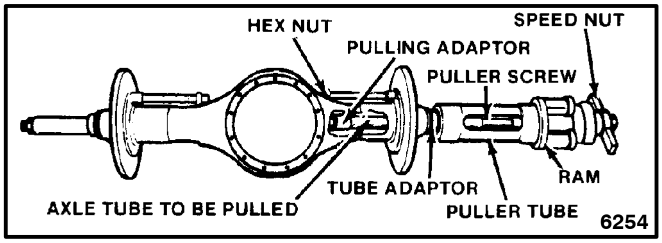


Figure 103. Removing Axle Tube

1. Place the pulling adaptor in position at the end of the axle tube inside the axle housing.

2. Place the tube adaptor in position at the hub end.

3. Insert the puller screw in the axle tube and secure the pulling adaptor with the hexnut.

4. Place the puller tube against the tube adaptor.

5. Place the hydraulic ram in position. Apply the speed nut against the ram head as shown.

6. Connect the ram to the hydraulic pump and apply pressure. The load tube will be withdrawn from the axle housing with continued applications of pressure.

Installation

To install the new load tube, follow these steps (refer to Figure 104):

1. Insert the two puller screws in the axle housing and connect them with the connecting nut as shown.

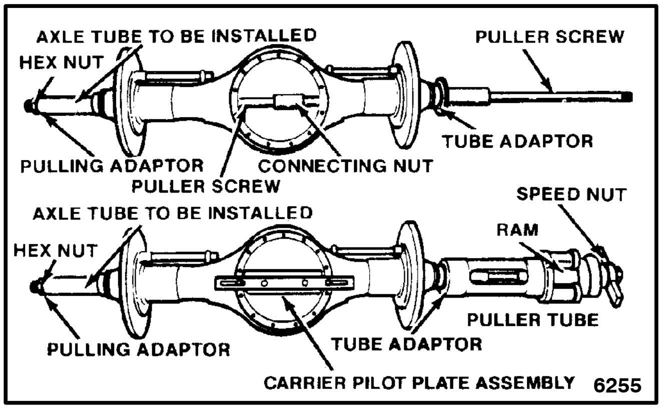

AXLE TUBE TO BE INSTALLED
HEX NUT
PULLER SCREW
TUBE ADAPTOR
PULLING ADAPTOR
CONNECTING NUT
PULLER SCREW
AXLE TUBE TO BE INSTALLED
SPEED NUT
HEX NUT
RAM
PULLER TUBE
PULLING ADAPTOR
TUBE ADAPTOR
CARRIER PILOT PLATE ASSEMBLY
6255

Figure 104. Installing Axle Tube

2. Place the axle tube in position at the end of the axle housing.

3. Place the pulling adaptor in position at the outside end of the new tube. Also place one in the opposite end as a guide and secure the puller screw with the hexnut as shown.

4. Place the tube adaptor in position at the opposite end of the axle housing.

5. Place the puller tube in position against the tube adaptor as shown.

6. Install the carrier pilot plate assembly.

7. Position the hydraulic ram and screw the speed nut tightly against the ram head.

8. Connect the ram to the hydraulic pump and apply pressure until the load tube flange is flush with the end of the axle housing.

TORQUE SPECIFICATIONS

1. The torque values in the fastener torque chart are for fasteners that have a light application of oil on the threads.

2. If the fasteners are dry, increase the torque values by 10%.

3. If the fasteners have a heavy application of oil on the threads, decrease the torque values by 10%.

4. If you do not know the size of the fastener that is being installed, measure the fastener. Use the following procedure.

American Standard Fasteners

A. Measure the diameter of the threads in inches, dimension X (Figure 105).

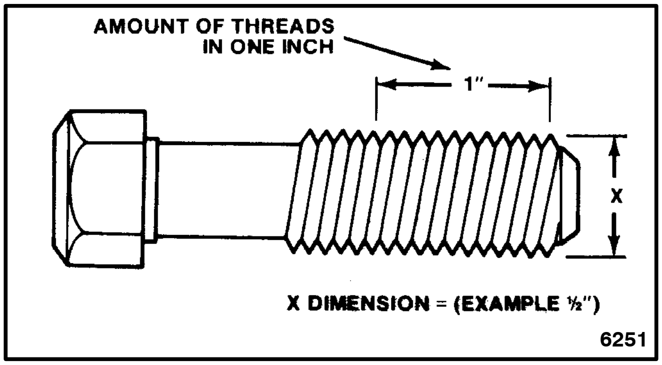

AMOUNT OF THREADS IN ONE INCH
1"
X
X DIMENSION = (EXAMPLE ½")
6251

Figure 105. Determining Size of American Standard Fastener

B. Count the amount of threads there are in one inch (Figure 105). Example of an American Standard Size fastener is 0.50 - 13. The 0.50 is the diameter of the fastener in inches (dimension X). The 13 is the number of threads in one inch.

Metric Fasteners

A. Measure the diameter of the threads in millimeters (dimension X) (Figure 106).

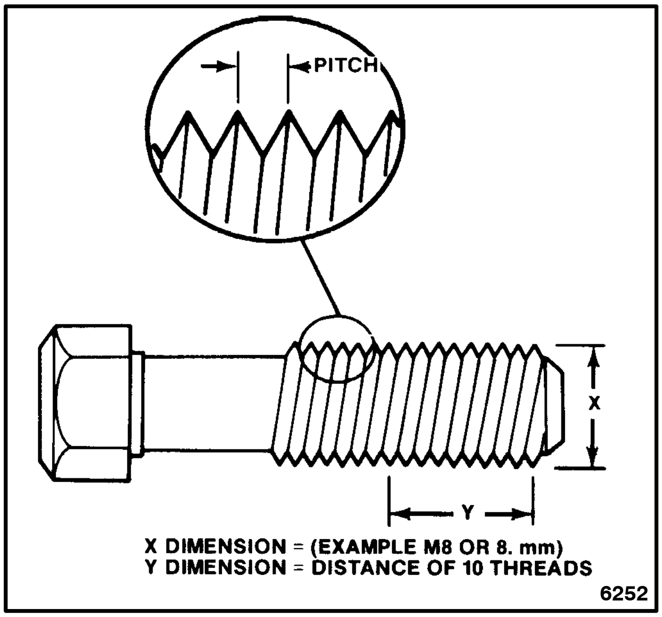
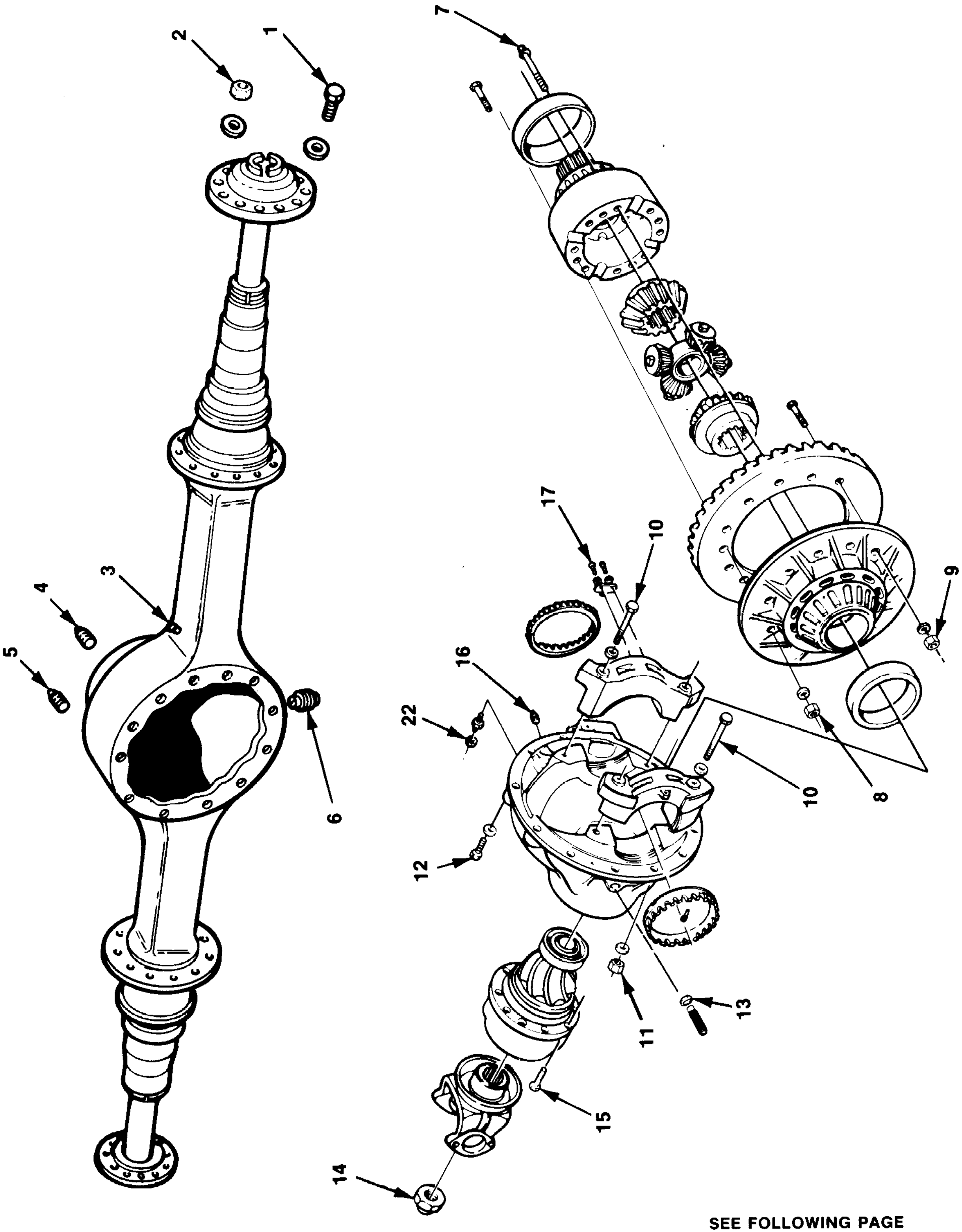

PITCH
X
Y
X DIMENSION = (EXAMPLE M8 OR 8. mm)
Y DIMENSION = DISTANCE OF 10 THREADS
6252

Figure 106. Determining Size of Metric Fastener

B. Measure the distance of 10 threads, point to point in millimeters (mm), dimension Y. Make a note of dimension Y (Figure 106).

C. Divide dimension Y by 10. The result will be the distance between two threads or pitch. Example of a Metric size fastener is M8 x 1.25. The M8 is the diameter of the fastener in millimeters (mm) (dimension X). The 1.25 is the distance between two threads or pitch.

D. Compare the size of fastener measured in step 4 to the list of fasteners in the following chart to find the correct torque value (Figure 107).


2
1
7
3
4
5
6
17
10
9
16
22
8
10
12
11
13
15
14
6253

SEE FOLLOWING PAGE FOR DESCRIPTIONS & TORQUE VALUES.

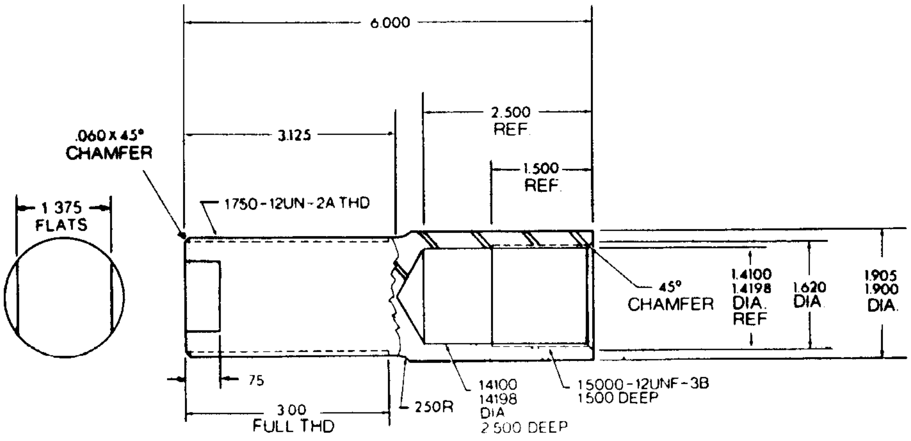
Figure 107. Determining Size of Metric Fastener

	FASTENER		THREAD SIZE	TORQUE VALUE	
				lb-ft	N·m
1.	Capscrew, Axle Shaft		.31–24	18–24	24–33
			.50–13	85–115	115–156
2.	Nut, Axle Shaft Stud		Plain Nut		
			.55–30	50–75	68–102
			.50–20	75–115	102–156
			.56–18	110–165	149–224
			.62–18	150–230	203–312
			Lock Nut		
			.44–20	40–65	54–88
			.50–20	65–100	88–136
			.56–18	100–145	136–197
			.62–18	130–190	176–258
3.	Breather		.38–18	20 min.	27 min.
4.	Plug, Oil Filter (Housing)		.75–14	35 min.	47.5 min.
5.	Plug, Heat Indicator		.50–14	25 min.	34 min.
6.	Plug, Oil Drain		.50–14	25 min.	34 min.
7.	Capscrew, Differential Case		.38–16	35–50	48–68
			.44–14	60–75	81–102
			.50–13	85–115	115–156
			.56–12	130–165	176–224
			.62–11	180–230	244–312
		Flange Head	M12 x 1.75	85–103	115–140
		Standard Hex Head	M12 x 1.75	75–95	100–130
			M16 x 2	203–251	275–340
8.	Nut, Differential Case Bolt		.50–13	75–100	102–136
			.50–20	85–115	115–156
			.62–11	150–190	203–258
			.62–18	180–230	244–312
			M12 x 1.75	74–96	100–130
9.	Nut, Ring Gear Bolt		.50–13	75–100	102–136
			.50–20	85–115	115–156
			.62–11	150–190	203–258
			.62–18	180–230	244–312
			M12 x 1.25	66–81	90–110
			M12 x 1.75	77–85	104–115
		Flange Head	M16 x 1.5	192–214	260–290
		Standard Hex Head	M16 x 1.5	190–225	260–305
10.	Capscrew, Bearing Cap		.56–12	110–145	149–197
			.62–11	150–190	203–258
			.75–10	270–350	366–475
			.88–14	360–470	488–637
			.88–9	425–550	576–746
			M16 x 2	181–221	245–300
			M20 x 2.5	347–431	470–585
			M22 x 2.5	479–597	650–810
11.	Nut, Housing to Carrier Stud		.44–20	50–75	68–102
			.50–20	75–115	102–156
			.56–18	110–165	149–224
			.62–18	150–230	203–312

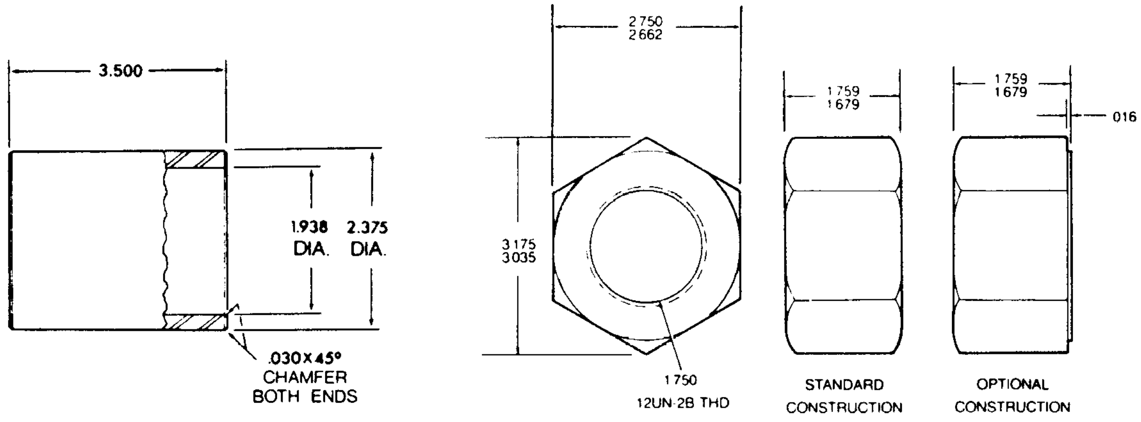
	FASTENER		THREAD SIZE	TORQUE VALUE lb-ft	N·m
12.	Capscrew, Carrier to Housing		.44–14 .50–13 .56–12 .62–11 .75–10 M12 x 1.75 M16 x 2	50–75 75–115 110–165 150–230 270–400 74–89 181–221	68–102 102–156 149–224 203–312 366–542 100–120 245–300
13.	Jam Nut, Thrust Screw		.75–16 .88–14 1.12–16 M22 x 1.5 M30 x 1.5	150–190 150–300 150–190 148–210 236–295	203–258 203–407 203–258 200–285 320–400
14.	Nut, Drive Pinion		.88–20 1.0–20 1.25–12 1.25–18 1.50–12 1.50–18 1.75–12 M32 x 1.5 M39 x 1.5 M45 x 1.5	200–275 300–400 700–900 700–900 800–1100 800–1100 900–1200 738–918 922–1132 996–1232	271–373 407–542 949–1220 949–1220 1085–1491 1085–1491 1220–1627 1000–1245 1250–1535 1350–1670
15.	Capscrew, Bearing Cage		.38–16 .44–14 .50–13 .56–12 .62–11 M12 x 1.75	30–50 50–75 75–115 110–165 150–230 74–96	41–68 68–102 102–156 149–224 203–312 100–130
16.	Plug, Oil Filter (Carrier)		.75–14 1.5–11.5 M24 x 1.5	25 min. 120 min. 35 min.	34 min. 163 min. 47 min.
17.	Capscrew, Lock Plate		.31–18 M8 x 1.25	20–30 21–26	27–41 28–35

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.


6.000
3.125
2.500 REF.
1.500 REF.
.060 X 45° CHAMFER
1 375 FLATS
1750-12UN-2A THD
45° CHAMFER
1.4100 1.4198 DIA. REF
1.620 DIA
1.905 1.900 DIA.
75
3 00 FULL THD
250R
14100 14198 DIA 2 500 DEEP
15000-12UNF-3B 1500 DEEP

20-143 Shaft

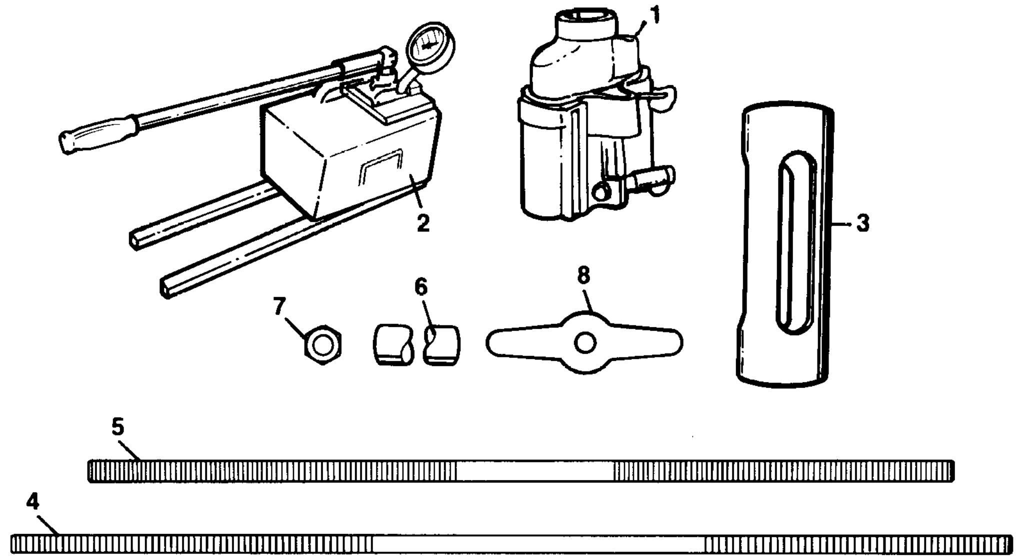

3.500
1.938 DIA.
2.375 DIA.
.030X45° CHAMFER BOTH ENDS
2 750 2 662
3 175 3 035
1 759 1 679
1 759 1 679
016
1 750 12UN 2B THD
STANDARD CONSTRUCTION
OPTIONAL CONSTRUCTION

20-144 Collar **20-145 Nut**

20–142 Tool Kit – Yoke Installation.

6256

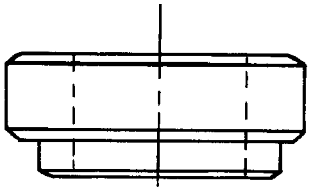
DRIVE AXLE TUBE PULLING TOOLS



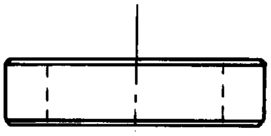
CONTENTS OF 20-313 SET

1 — 100 TON HYDRAULIC RAM
2 — TWO SPEED HYDRAULIC PUMP
3 — PULLER TUBE
4 — PULLER SCREW 71″
5 — PULLER SCREW 59″
6 — CONNECTING NUT
7 — HEX NUT
8 — ADJUSTING SPEED NUT

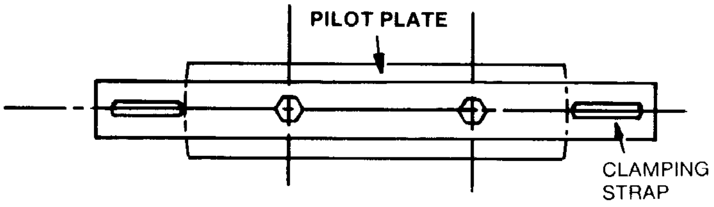
6257



* 20-314 PULLING ADAPTOR



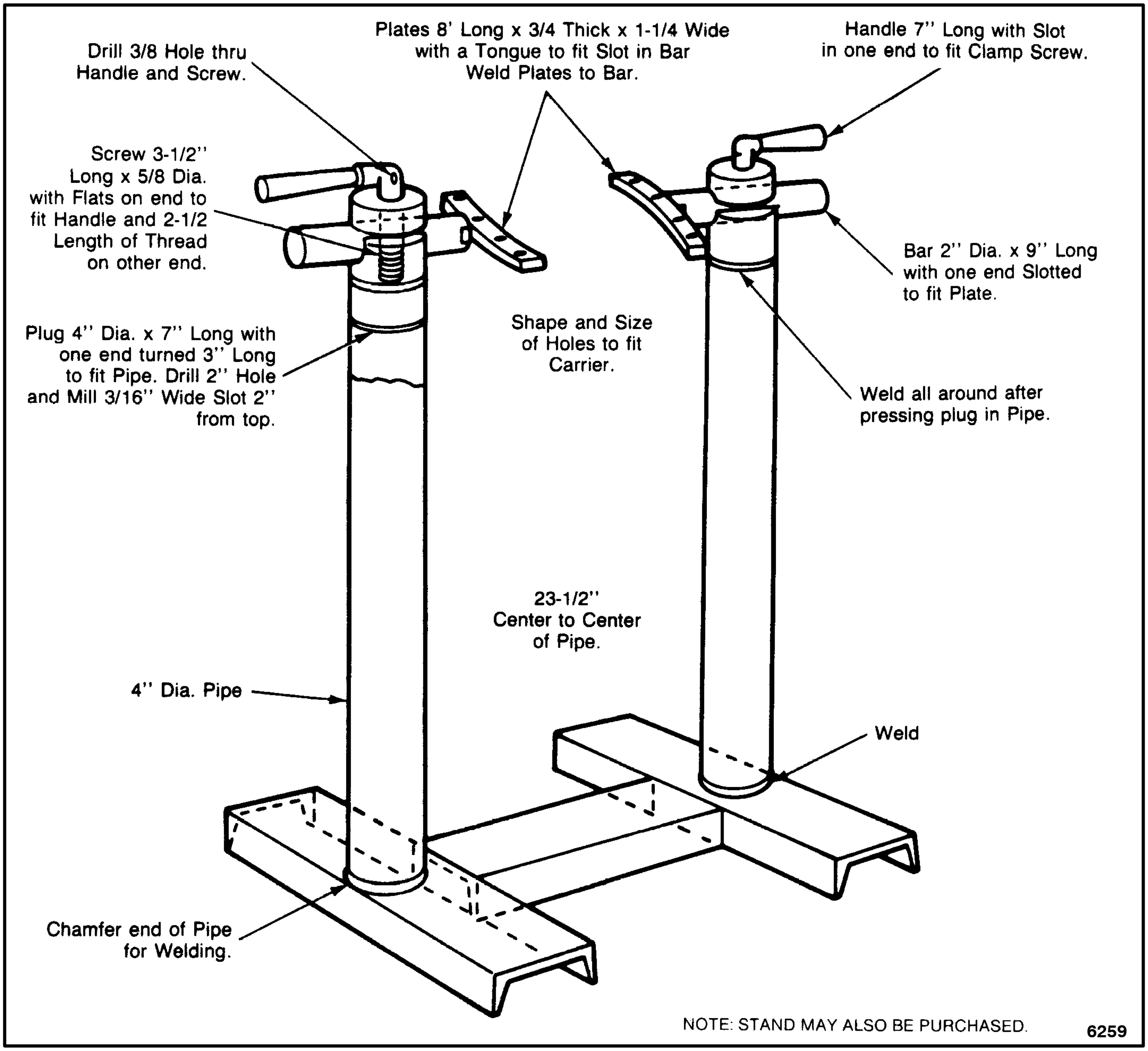
* 20-315 TUBE ADAPTOR



* 20-316 CARRIER PILOT PLATE

* 20-317 CLAMPING STRAP

6258


Drill 3/8 Hole thru Handle and Screw.
Plates 8' Long x 3/4 Thick x 1-1/4 Wide with a Tongue to fit Slot in Bar Weld Plates to Bar.
Handle 7" Long with Slot in one end to fit Clamp Screw.
Screw 3-1/2" Long x 5/8 Dia. with Flats on end to fit Handle and 2-1/2 Length of Thread on other end.
Bar 2" Dia. x 9" Long with one end Slotted to fit Plate.
Plug 4" Dia. x 7" Long with one end turned 3" Long to fit Pipe. Drill 2" Hole and Mill 3/16" Wide Slot 2" from top.
Shape and Size of Holes to fit Carrier.
Weld all around after pressing plug in Pipe.
23-1/2" Center to Center of Pipe.
4" Dia. Pipe
Weld
Chamfer end of Pipe for Welding.
6259

NOTE: STAND MAY ALSO BE PURCHASED.

SPECIFICATIONS

DRIVE AXLE ASSEMBLY

Manufacturer	Rockwell Standard
Wheel Track (Center of Dual Wheels)	76.62” (1946 mm)
Gear Type	Hypoid
Axle Type	Pressed Steel Housing
Rear Axle Ratio (Basic)	3.73:1
Rear Axle Lube Capacity	20 Qts. (19 liters)

CLEARANCE

Differential Bearing End Play	0.000” (0.000 mm)
Differential Gear Run–Out Max.	0.008” (0.203 mm)
Hypoid Gear Backlash (New)	0.010” (0.254 mm)
Hypoid Gear Backlash Limits	0.005”–0.015” (0.127 mm–0.381 mm)

SECTION 2B1

TRAILING AXLE - SELF-STEERING (MODEL 102DL3)

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 2B1-1
Components 2B1-2
Lubrication 2B1-2
Maintenance 2B1-3
Troubleshooting 2B1-16
Torque Specifications 2B1-17
Specifications 2B1-18
Service Tools 2B1-19

GENERAL DESCRIPTION

This coach model features a self-steering trailing axle assembly independently mounted behind the drive axle assembly. The axle (Figure 1) similar in function to the front axle, but, also incorporates provisions that enable recastering of the axle assembly for forward or reverse coach travel. This recastering feature allows the trailing axle to react efficiently to situations requiring self-steering or tracking function. Some of the mechanical components associated with this feature are part of the suspension support truss assembly, which is bolted to the axle assembly. More information on these components can be found in Section 12.

The pivot action allows the wheels to track while driving or backing. This self-castering function is achieved by rotating the spindle centerlines about the lateral axis of the trailing axle. Actuation is by an air cylinder attached the the truss which applies a force through an arm attached to the axle. This action provides a caster from positive 3 degrees (Forward Travel) to negative 3 degrees (Reverse Travel).

The castering action from forward to reverse is achieved through a solenoid-operated air-actuated latching cylinder. The mechanical latch mechanism, operated by the air cylinder, assures that braking loads are not transmitted through to the cylinder. Tag axle reverse castering action is triggered by the back-up light circuit.

A tie rod locking system is incorporated on the trailing axle. At highway speed, the mechanism automatically locks the axle straight by way of an air cylinder. When the tie rod assembly is locked, skid control for the trailing axle assembly is restored.

In the event of a caster-actuating mechanism malfunction, an override switch is provided to lock the tie rod. This cancels the self-caster system enabling the coach to operate in a non-castering mode until it can be serviced.

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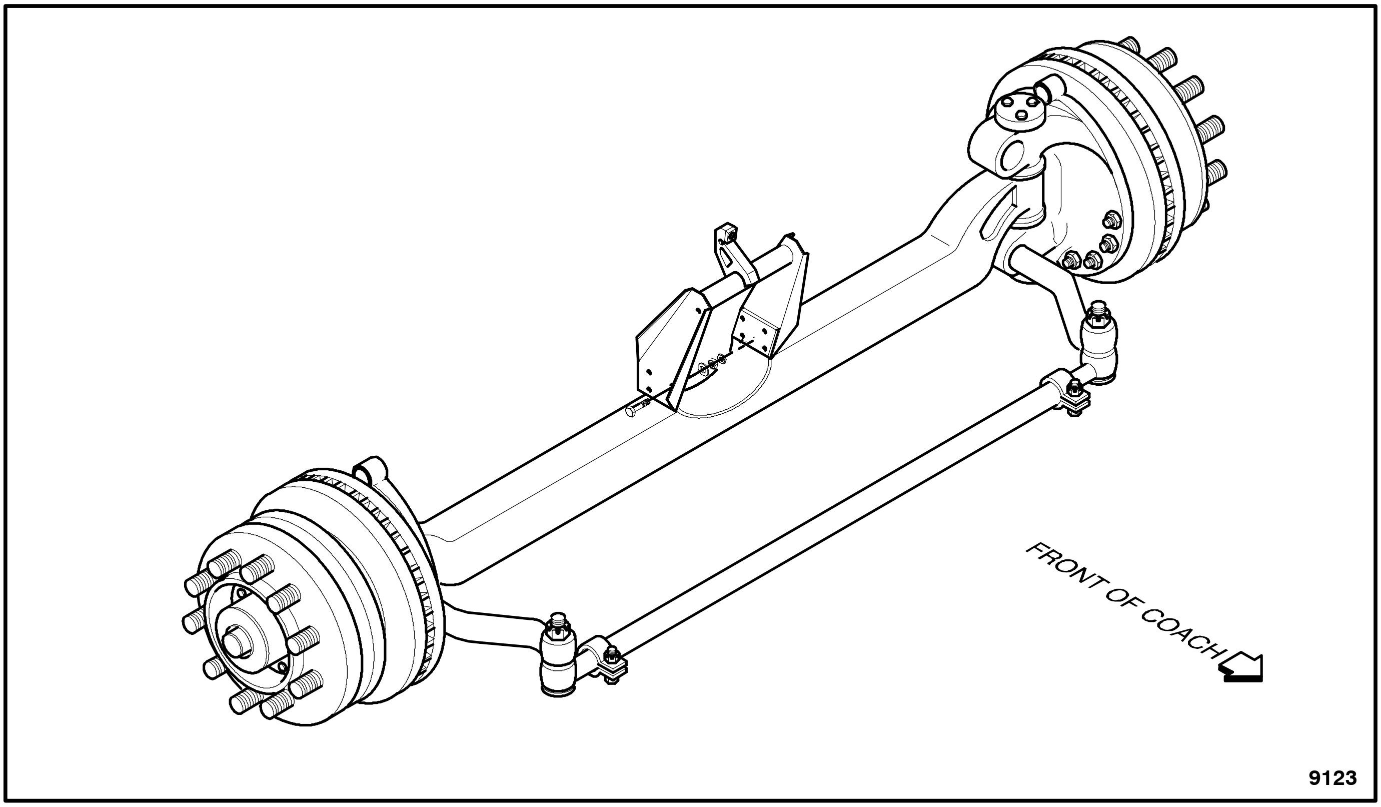


Figure 1. Trailing Axle

COMPONENTS

The axle consists of a square tube center section with attachment plate and integral forged steel knuckle ends. The axle center is modified to allow for both drive shaft clearance, and mounting of the caster-action locking arm. The trailing axle capacity is rated at 12,000 lbs. (5443.2 kg).

The tubular style axle has approximately two quarts of diesel fuel installed in the hollow tube section to aid in detection of any fatigue or stress cracking. Any axle which shows signs of leakage should be inspected and/or replaced.

The axle is fitted with disc-brake knuckle assemblies only. The knuckles have grease fittings in both knuckle pin bosses for lubrication of the knuckle bushings. The bushings are of the “Easy Steer” type. Covers and plugs prevent dust and moisture from entering bushings and serve as seals. Stop screws installed on each knuckle assembly limit turning angle of the wheels.

The knuckles are bushed in the upper and lower pin bosses so that they may turn freely about the pins. Bushings are grooved on the inside to allow grease to flow uniformly to high-pressure areas. Grease fittings are installed at both upper and lower knuckle pin bosses. A straight type knuckle pin is used. The straight type pin is held in place by two draw keys located in the axle ends.

Knuckle assemblies are connected through tie rod arms to the tie rod assembly. The tie rod is threaded at each end to accept non-repairable tie rod ends held in position by clamps. Right-hand and left-hand threads are provided on the tie rod to facilitate toe-in adjustment.

Hubs and drums, wheel bearings, air suspension, and brake parts which are mounted to the axle assembly are described in the applicable sections of this manual.

LUBRICATION

Periodic lubrication according to the recommendations in the lubrication section of this manual should be carried out. Points which require lubrication are the knuckle pins, the bushings, the ends of the cross tube assemblies, and the ball stud ends of the drag link. These are provided with grease fittings for pressure lubrication. Either of the following lubricants should be used.

Chassis Grease, 6% 12-hydroxy lithium stearate grease, NLGI Grade No. 1.

Chassis Grease, 8% 12-hydroxy lithium stearate grease, NLGI Grade No. 2.

NOTE: The wheel bearings also require periodic lubrication. Refer to Section 15 of this manual for information on the wheel bearings.

NOTE: Permanently lubricated ball studs do require lubrication. Inspect the boot seal every 96,000 miles (80,000 km) or every 12 months, whichever occurs first.

There are two procedures for lubricating the knuckle pins. One for new axles, before the coach is placed in service; the other for lubricating the knuckle pins after 4,000 miles (6,500 km).

PROCEDURE TO BE USED FOR NEW AXLE:

1. Raise the coach so that the tires are off the ground.

2. Lubricate the pins through the grease fittings on the top and bottom of the knuckle (Figure 2). Apply lubricant until new lubricant comes from the area between the seal of the thrust bearing and the upper shim pack.

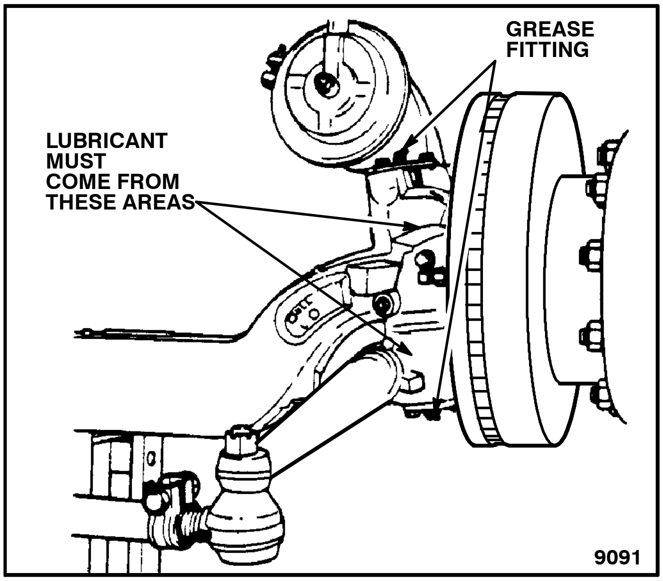


Figure 2. Knuckle Pin Lubrication

3. Lower the tires to the ground.

4. Relubricate the pins through the grease fittings on the top and bottom of the knuckle. Apply lubricant until new lubricant comes from the area between the seal of the thrust bearing and the upper shim pack.

PROCEDURE TO BE USED AFTER AXLE HAS 4,000 MILES (6,500 KM) OF SERVICE.

1. Make sure the tires are touching the ground.

2. Lubricate the pins through the grease fittings on the top and bottom of the knuckle. See Figure 2.

3. Apply lubricant until new lubricant comes from the area between the seal of the thrust bearing and the upper shim pack.

Lubricate the cross tube according to the following procedure.

1. Make certain the tires are touching the ground.

2. Apply grease through the grease fittings on the assembly (Figure 3).

3. Apply lubricant until new lubricant comes from the boot.

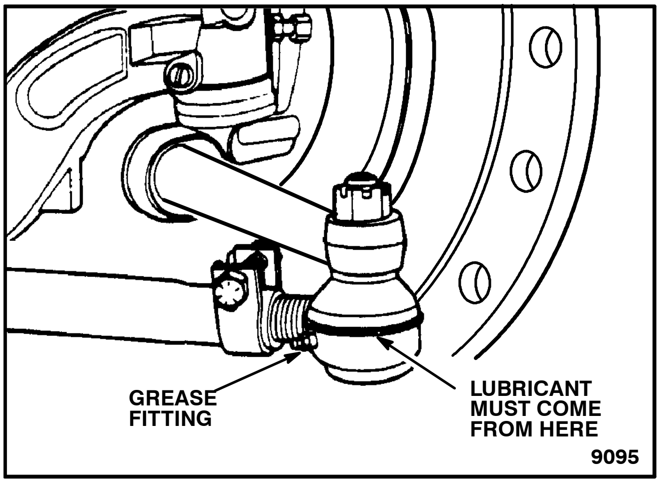


Figure 3. Cross Tube Lubrication

MAINTENANCE

Periodic inspection of the axle assembly should be made to see that all bolts are tight and that no damage or distortion has taken place. Suspension support stud nuts, V-bolt nuts, tie rod arm nuts, and stop screws should be checked and tightened if necessary to the torque specifications shown at the end of Section 12. Attention should also be given to the condition of the knuckle pin and bushings. If excessive clearance is found bushings and pins should be replaced.

The axle manufacturer recommends that the “Easy Steer” knuckle pin bushings be replaced when the range of side-to-side tire movement reaches 0.30-inch or when the bushings are worn to a maximum of 0.01-inch on their diameter.

NOTE: These measurements are made with the wheel bearings tightened on the spindle.

With new bushings installed, the range of side-to-side tire movement should not exceed 0.01 inch maximum (Figure 4).

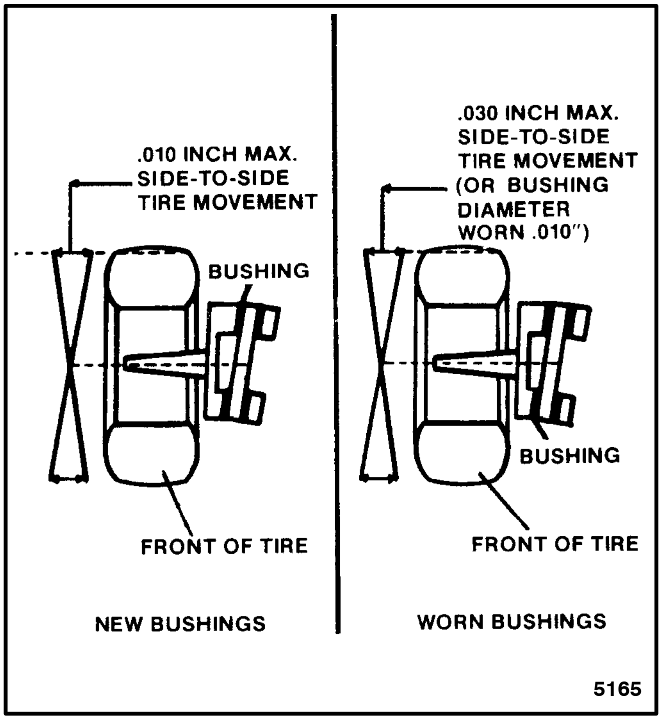


Figure 4. Side-To-Side Tire Movements With New and Worn Knuckle Pin Bushings

Looseness in the linkage under normal loads is sufficient cause to immediately check all pivot points for wear, regardless of accumulated mileage. Linkage pivot points should be checked each time the axle assembly is lubricated. If any indication of lateral movement is found, cross tube ends should be removed for inspection.

NOTE: Knuckles, knuckle pins, and bushings may be replaced without removing the axle from the coach.

WARNING

Do not attempt to repair, remove or reinstall front axle with the vehicle supported by jacks only.

AXLE REMOVAL

To remove the entire axle assembly, raise the coach with jacks until the bottom of the coach body is approximately 18 inches (457.2 mm) from the floor. Block the body in this position as indicated in Section 3 under Coach Jacking Points.

CAUTION

Do not raise the body in such a way that the entire weight of the axles will hang on the suspension bellows assemblies. Damage to the air springs may result.

1. Remove tires and wheels as detailed in Section 15.
2. Exhaust air pressure from the suspension air tank by opening drain at bottom, after blocking axle truss to prevent bellows damage.
3. Disconnect and exhaust air from the trailing axle air bellows.
4. Disconnect the hose from the brake chambers.
5. Disconnect both ends of all radius rods as outlined in Section 12.
6. Remove all bolts attaching the axle truss to axle attachment plate at center of axle, and truss clamps at each end of the axle.
7. Remove shock absorbers as outlined in Section 12.
8. Lower the axle assembly on jacks. The axle can now be carefully removed from under the vehicle.

AXLE INSTALLATION

Reverse this procedure to reinstall the axle assembly. Make sure that air springs mounting pads on axle towers are clean.

KNUCKLE ASSEMBLY

The axle's steering knuckle construction has straight knuckle pins. Note the knuckle assembly as installed on the axle (Figure 5).

Removal

1. Block the rear wheels to prevent the vehicle from rolling. Jack up the axle so that tires clear floor. Block up securely at this position and remove jacks. Refer to Section 3 "Coach Jacking Points".

WARNING

Do not attempt to disassemble or perform knuckle repair with vehicle supported by jacks only.

2. Remove wheels, hubs and bearings as directed in Section 15.

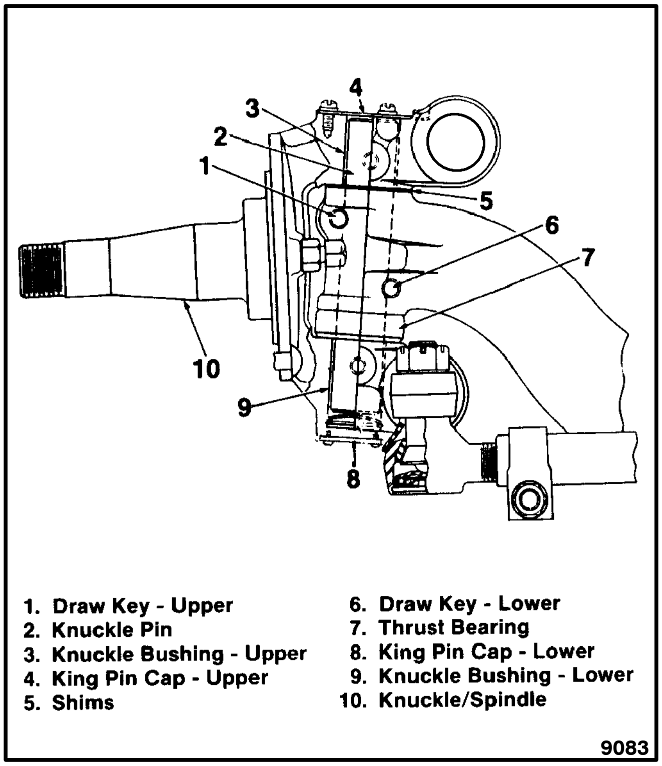


Figure 5. Steering Knuckle

3. Remove brake chambers and brake hardware from steering knuckle. Detach brake assembly from knuckle and remove (with slack adjuster) as an assembly.

4. Remove the capscrews from the knuckle pin covers and the gaskets beneath the cover (Figure 6).

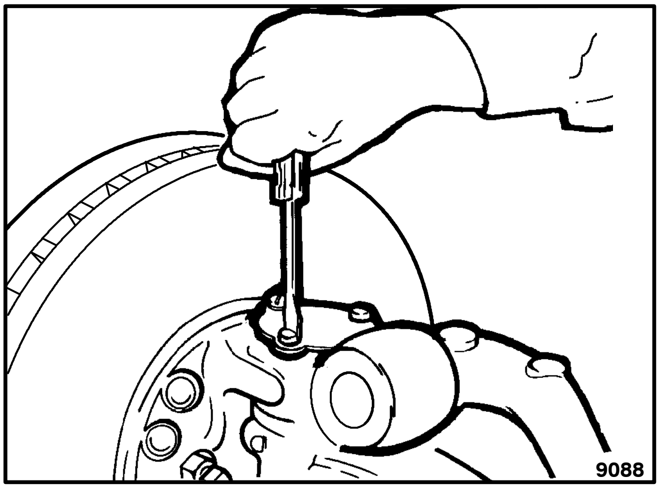


Figure 6. Removing Knuckle Pin Cover

5. The straight style knuckle pin is retained in the knuckle by means of threaded draw keys at the top and bottom of the knuckle. Remove the draw keys as follows:

6. Loosen locknut on key and turn it out to the end of the threads. The end of the nut should be flush with the draw key end.

7. With a brass drift and a hammer, firmly strike the end of the nut to loosen the draw key.

NOTE: Failure to strike the draw key squarely may result in a damaged key, causing removal difficulties.

8. Remove the nut and key from the axle center.

The knuckle pin is removed from the knuckle by tapping it out using a bronze drift (Figure 7).

NOTE: The following precautions and procedures will allow the pins to be removed with minimum danger of personal injury or damage to the knuckle pins and bushings.

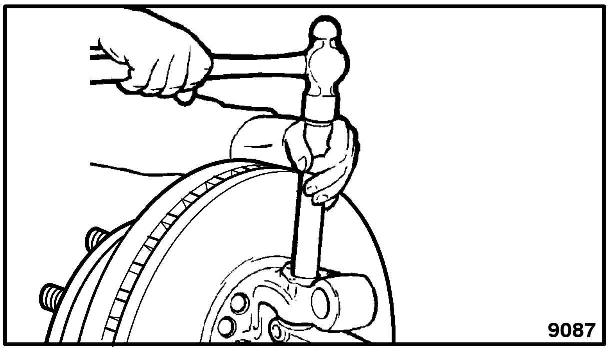


Figure 7. Removal of Knuckle Pin

9. Straight type knuckle pins may be removed through either the top or bottom of the knuckle.

10. **Do not** strike the knuckle pin directly with a steel hammer. The pins are made of hardened steel. Personal injury can result from flying chips and splinters and, in the case of the tapered style pin, the threads on the upper end will be damaged.

11. If the bushings are not to be replaced, precautions must be taken not to damage them with the bronze drift. Grind off any flaring on the end of the drift which will contact the pin. Wrap tape around the drift $\frac{1}{16}$-inch thick for the first inch from the end of the drift. This is especially important when the bushings are of the “Easy Steer” type used with the straight type knuckle pin.

12. Lift off the knuckle assembly, thrust bearing and shims (Figure 8).

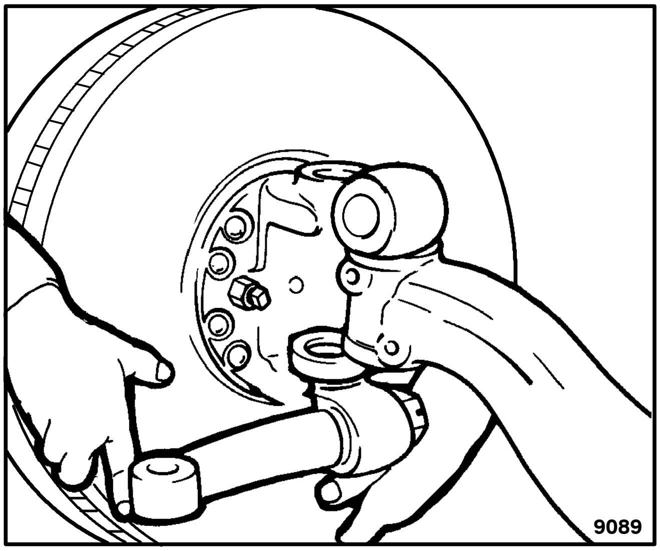


Figure 8. Removing Steering Knuckle from Axle

Bushings

The axle has Rockwell “Easy Steer” bushings.

Tool 20-5 should be used when removing or replacing the bushings. Tool 20-312 should be used to size the bushings.

The tools can be made from round steel bar stock. A reaming tool (PN 20-312) for the “Easy Steer” type bushings may also be purchased.

Removal

Tool 20-5 and a press of at least 5-ton capacity is required to remove or install the bushings in the knuckles.

Before beginning the removal or installation of the bushings, fix the knuckle firmly on the bed of the press to avoid knuckle slippage during the bushing removal or installation.

To remove the bushings, insert the tool’s pilot end into the bore of the bushing and press the bushing from the knuckle.

Installation:

1. Press the upper bushing approximately ⅛-inch into the knuckle and relieve the press pressure. Check alignment of tool and bushing.

2. The bushing can now be pressed to the desired depth of 0.477 - 0.507-inch from the top of the machined surface (Figure 9).

3. Place the knuckle bottom side up and repeat step 1.

4. Press the lower bushing in to a depth of 0.412 - 0.442-inch from the bottom machined surface (Figure 9).

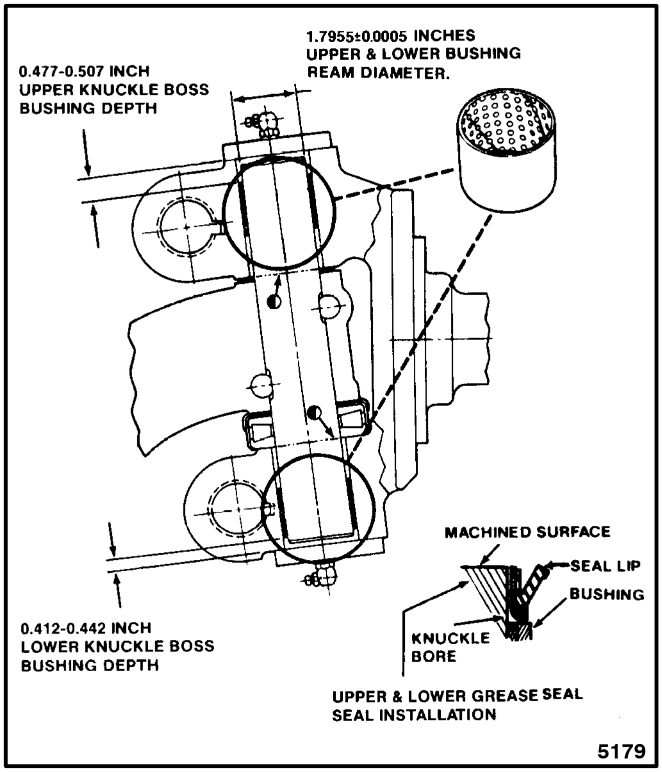

1.7955±0.0005 INCHES
UPPER & LOWER BUSHING
REAM DIAMETER.
0.477-0.507 INCH
UPPER KNUCKLE BOSS
BUSHING DEPTH
MACHINED SURFACE
SEAL LIP
BUSHING
KNUCKLE
BORE
0.412-0.442 INCH
LOWER KNUCKLE BOSS
BUSHING DEPTH
UPPER & LOWER GREASE SEAL
SEAL INSTALLATION
5179

Figure 9. Easy Steer Bushing and Grease Seal Installation

NOTE: Do not install the grease seals until the reaming is completed.

5. Using reamer 20-312, finish the bushings to 1.7950 - 1.7960-inch diameter. The bushings must also be in line with each other to within 0.001-inch. Refer to the sizing procedure described later in this section.

SIZING NEW BUSHINGS

There are several methods of sizing the bushings but the only method which will give accurate size and alignment of the bore is reaming. Honing and burnishing do not provide good, bushing bore alignment. Easy steer bushings are made of too resilient a material for them to be sized with a burnishing ball or bar.

The recommended procedure for reaming the bushings is as follows:

1. Position the knuckle in a vise with soft metal shims to protect the knuckle. It is preferable to have the knuckle pin hole vertical.

2. Gently slide the reamer pilot through the upper bushing until the reamer cutters begin to engage the upper bushing (Figure 10).

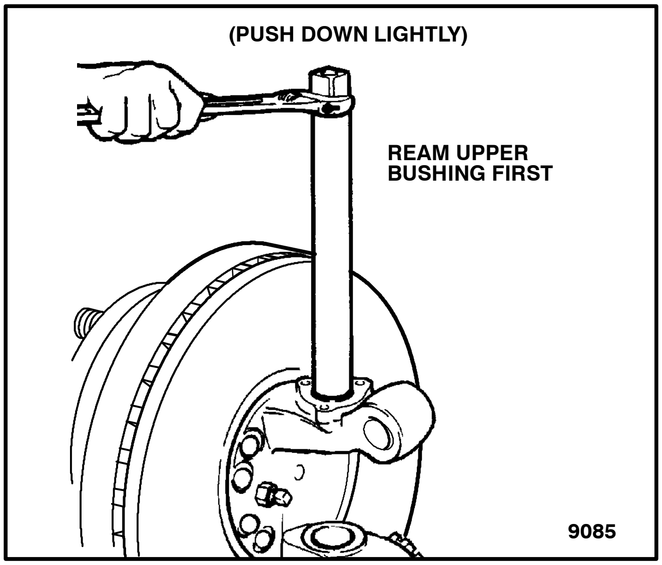


Figure 10. Sizing Upper Bushing

3. Begin rotating the reamer and applying a light downward pressure with your hand at the same time. Do not force the reamer by applying too much downward force. The reamer can be rotated at any speed but should be done smoothly.

4. After the reamer sizes most of the upper bushing, support the reamer so that it does not drop to the bottom bushing as it completes the cut.

5. After the upper bushing has been sized, gently slide the reamer through until it engages the bottom bushing (Figure 11). Repeat steps 3 and 4 for the bottom bushing.

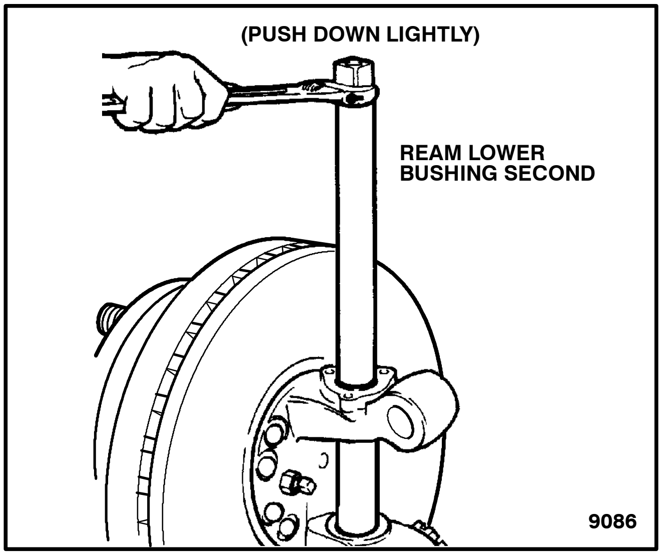


Figure 11. Sizing Lower Bushing

6. Slide the reamer out through the bottom. If the reamer must be pulled back up through the bushing, do so only while rotating the reamer in reverse. Any other way will damage the bushings.

7. Clear bushing debris from bores, and check that the pin will go through both bushing before installing seals.

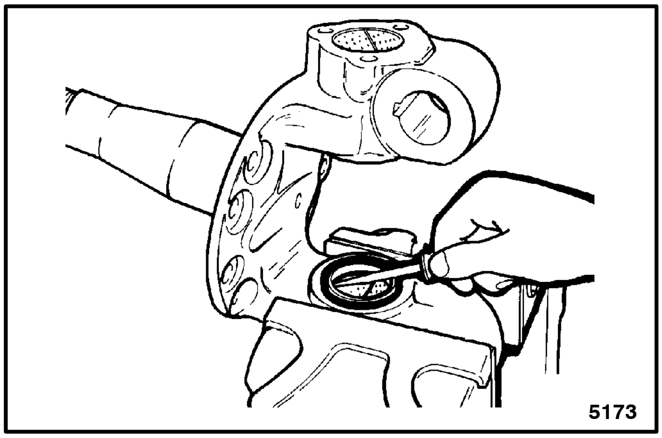


Figure 12. Grease Seal Removal

Knuckle Seals

Inspect the grease seals for tears, rips and deterioration. Do not remove the seals from the knuckle unless replacement is necessary or if the knuckle is to be rebushed. If seal is to be removed, pry it out with a screwdriver (Figure 12).

1. Place knuckle bottom side up in a vise equipped with soft metal protectors. Position upper knuckle boss (top end down) between jaws of vise and lock securely.

> **NOTE:** Seals must be oriented as shown. Reversal of a seal will prevent purging of grease.

2. With the top end of the knuckle held firmly in this position, place the seal over the knuckle counterbore, with the rubber lip facing up.

3. Using a suitable sleeve and a bronze drift (Figure 13), tap the seal into the knuckle bore until it is flush with the machined surface (Figure 14).

4. Repeat this procedure by reversing the knuckle for the lower seal.

> **NOTE:** In the absence of a suitable driver, do not tap the seal in with a hammer. Set the seal in the opening and cover it with a rigid flat metal plate. Tap the plate with a hammer directly over the seal until the seal is flush with the machined surface. Do not drive the seal any further.

KNUCKLE INSTALLATION

Thrust Bearing Installation

> **NOTE:** Some of the thrust bearings have the word “TOP” stamped on the flat face of the bearing retainer. The stamped word “TOP” should not be used for bearing installation purposes. Refer to the following instructions for proper bearing positioning.

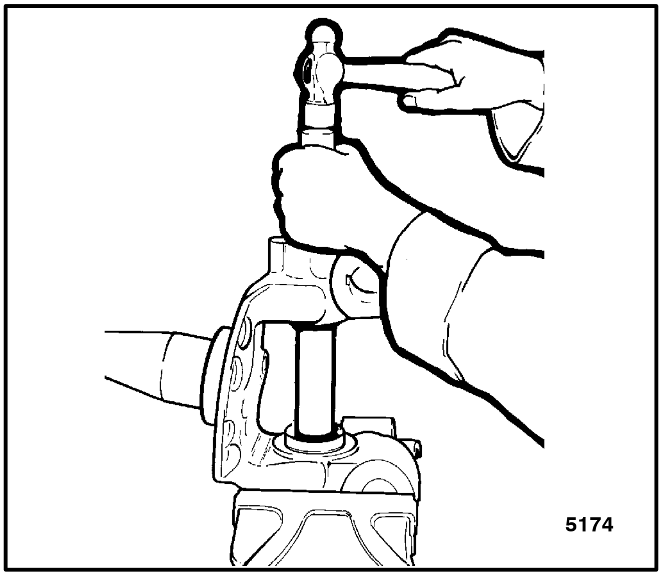


Figure 13. Installation of Grease Seal

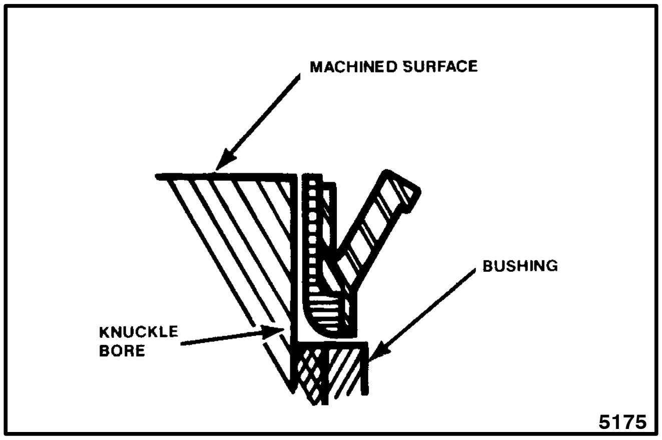


Figure 14. Grease Seal Installed in Knuckle

Prior to putting the thrust bearing in the axle center-knuckle assembly, assemble the bearing and seal by holding the bearing so that the opening between the bearing cage and the retainer is up. Then snap the seal securely over the opening (Figure 15).

The assembly of the axle center and knuckle now proceeds as follows:

1. Position and support the knuckle assembly on the axle center.

2. With the seal positioned on top of the thrust bearing, slide the bearing and seal assembly between the lower face of the axle center and the upper face of the knuckle yoke (Figure 16).

NOTE: The thrust bearing must be seated on the upper face of the lower knuckle yoke. The seal must cover the opening between the bearing cage and retainer. Always install the bearing and seal assembly in the axle with the seal on top. See Figure 16.

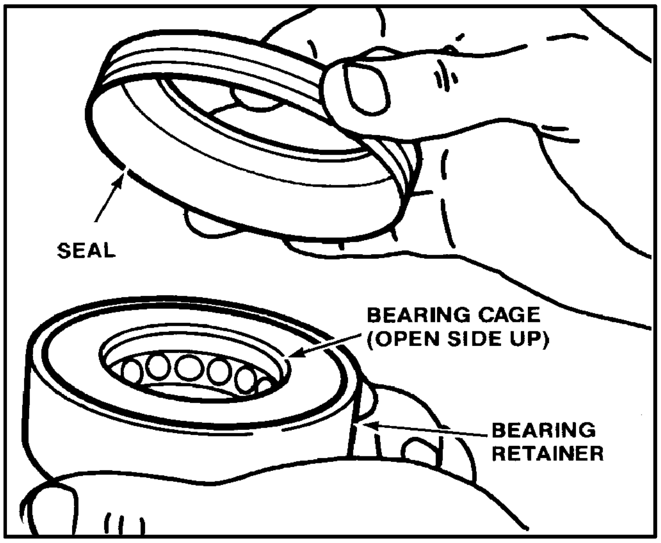

SEAL
BEARING CAGE (OPEN SIDE UP)
BEARING RETAINER

Figure 15. Bearing and Seal Assembly

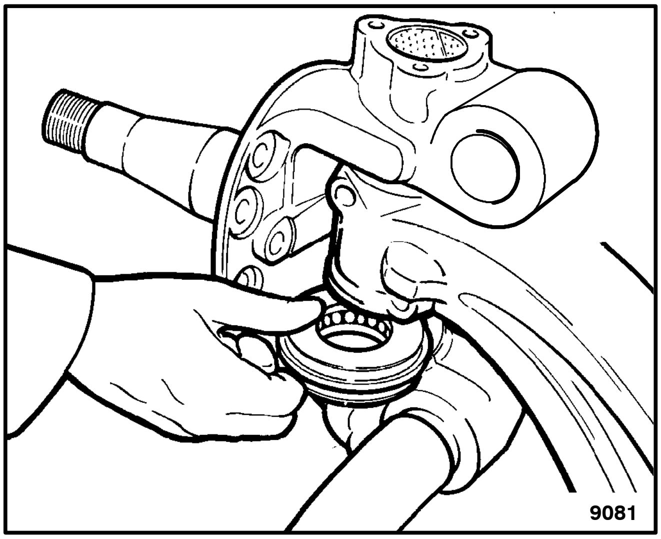


Figure 16. Installing Knuckle and Seal Assembly

3. Shimming of the knuckle to the axle assembly may be needed. Shims are positioned between the upper axle center face and the upper knuckle yoke. (Figure 17). Shims are used to limit the vertical movement of the knuckle with respect to the axle center and knuckle pin. Some clearance in this area is required, however, to allow grease to purge from the upper bushing area. Carefully inspect shims, new or used, to be sure none are kinked, bent or torn. Discard any that are damaged. Select a quantity of shims to obtain as little

vertical end play as possible. Lift the knuckle in position and slide the shim pack between the axle center boss and the knuckle upper yoke.

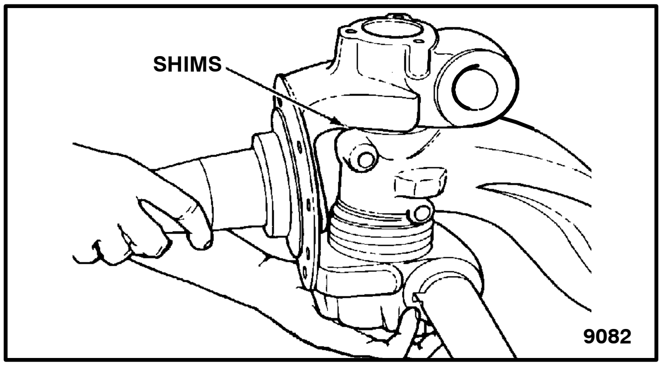


Figure 17. Shimming Axle and Knuckle

Alignment of the knuckle pin hole in the knuckle and axle center is now required for knuckle pin installation. While looking down through the knuckle pin hole, shift the knuckle to align it with the axle center. Now align the shims to be flush with the axle center around the entire circumference of the knuckle pin hole. The shim alignment can only be done through the upper bushing. Any protrusion of any portion of the shim will prevent the knuckle pin from passing through and result in a damaged shim.

CAUTION

Shims are delicate and sharp. Extreme caution should be exercised while aligning shims so as not to cut fingers or bend the inside diameter of the shims. Damage to the shims during this entire procedure requires disassembly and replacement of the damaged parts.

Knuckle Pin Installation

1. Smear clear chassis grease on the bottom half of the knuckle pin and insert it slowly into the top of the knuckle. Knuckle pins are marked with the Rockwell logo, part number and the word “top” on the top end of the pin. Rotate the pin to align the draw key slots with the draw key holes in the axle. Slowly push the pin through the bushing, seal and shim pack. The pin should slide through the shim pack freely. Any resistance greater than a hand push indicates misalignment. Remove the pin and realign the components. After the pin is inserted through the shim pack, a brass hammer may be used to assist in installation. Care must be taken not to dislodge the lower grease seal as the knuckle pin enters the lower knuckle yoke.
2. Center the knuckle pin in the knuckle to equalize the distance from the top and bottom surfaces.
3. Lightly tap the draw keys into position, flat side toward the knuckle pin; do not firmly seat them until after the end play measurement. Install the lower draw key from the front side and the upper draw key from the rear. Assemble so the wedged ends of the two keys contact the knuckle pin and torque to restrict pin from moving while the end play is measured.
4. Measure end play according to the procedure given later in this section and adjust if necessary.

NOTE: Never install both draw keys from the same side.

Seating Draw Keys - The knuckle pins are retained by draw keys.

5. After the specified end play is obtained, seat the draw keys firmly with a hammer and drift (Figure 18).

NOTE: Even though they are threaded, the keys must be solidly seated in this manner. The nut torque on the threaded design is only sufficient to hold the key in position and is not adequate to properly seat the key.

6. Install flanged locknut and torque to 30-40 ft-lbs (41-54.2 N·m).

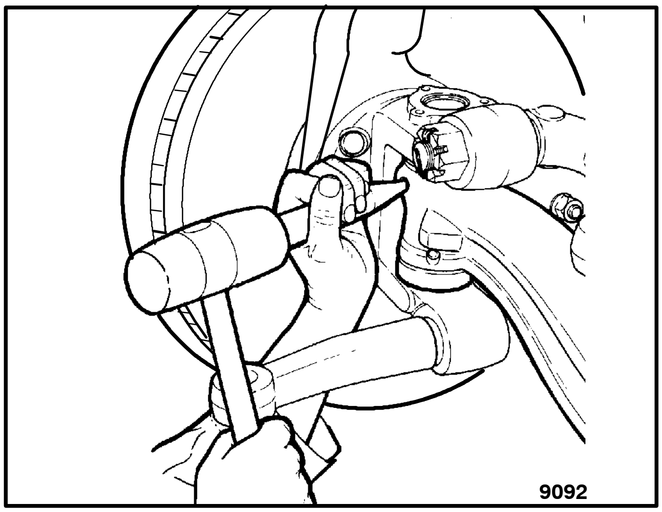


Figure 18. Seating Draw Keys

Installation of Knuckle Pin Caps:

NOTE: Before knuckle pin caps are installed, recheck draw keys to be sure the final staking or torquing procedure has been completed. Omission of the final knuckle pin securing steps may result in damaged or broken knuckle pins and axle centers.

1. Align knuckle pin caps and gaskets and assemble to knuckles with capscrews and washers.
2. Gaskets do not have a top or bottom orientation and may be installed in either position.
3. Caps do require orienting the flat side toward the gasket and knuckle. The flat, sealing side contains no numbering or lettering.
4. Torque fasteners to 20-30 ft-lbs (27-41 N·m).

Bushing Lubrication:

1. Grease upper bushing first, then the lower bushing. Use molybdenum disulfide grease. If grease does not flow through the thrust bearing, it will be necessary to raise the knuckle with a jack to close off passage of grease around the thrust bearing. Regrease the lower bushing and thrust bearing, then remove jack.
2. Rotate knuckle lock to lock to help distribute the grease. Note the knuckle will now be noticeably harder to rotate than during the end play measurement. This is normal.
3. Repeat step 11.
4. Fill the voids in the draw key holes with grease to prevent corrosion and ease future disassembly.
5. The steering knuckle/axle center reassembly is now complete.

Knuckle end play can be measured without hubs, brake spider, wheels and tires during rebuild as outlined in “Procedure 1”, or with the axle in service as in “Procedure 2”.

NOTE: Both knuckles should be checked.

NOTE: The use of shim gauges (feeler gauges) for measurement of clearance tolerances on knuckles is not recommended. These will not give an accurate reading of end play. Use only a dial indicator. End play is the free movement of the knuckle up and down along the axis of the knuckle pin. Some end play is required to prevent binding of the knuckle and to provide a passage for grease to purge during bushing lubrication. Excessive end play can cause interference between the knuckle pin and end caps or retainers.

Procedure 1

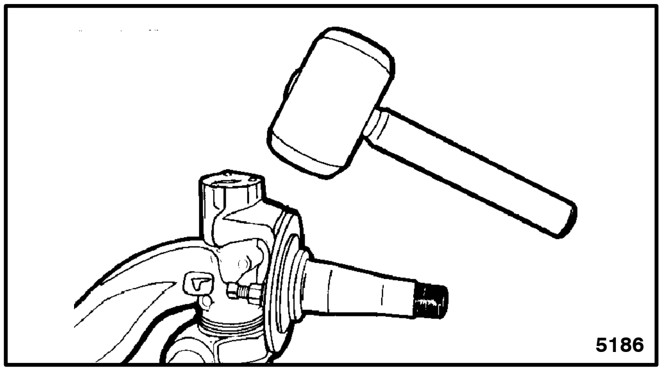


Figure 19. Striking Knuckle

1. With knuckle pin caps off, turn the knuckle to the straight ahead position. Take a rubber mallet and strike the top pin boss of the knuckle as shown. This will shift all of the components down and remove grease layers so an accurate reading may be taken (Figure 19).

NOTE: Attach the dial indicator with a “C” clamp or magnetic base to the knuckle spindle so that the knuckle can be turned freely (Figure 20).

2. Place the dial indicator plunger on the exposed end of the knuckle pin so that its line of action is approximately parallel to the knuckle pin center line (Figure 20).
3. Zero the dial indicator.
4. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement (Figure 21).

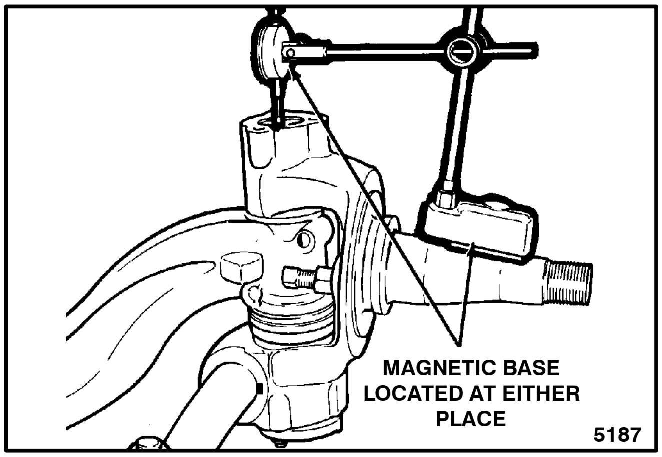


Figure 20. Dial Indicator Installation

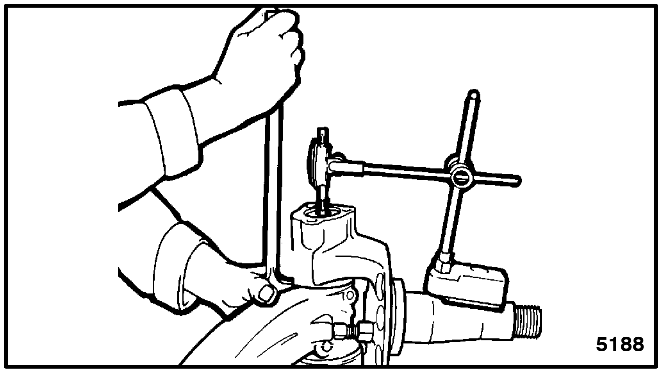


Figure 21. Measuring End Play

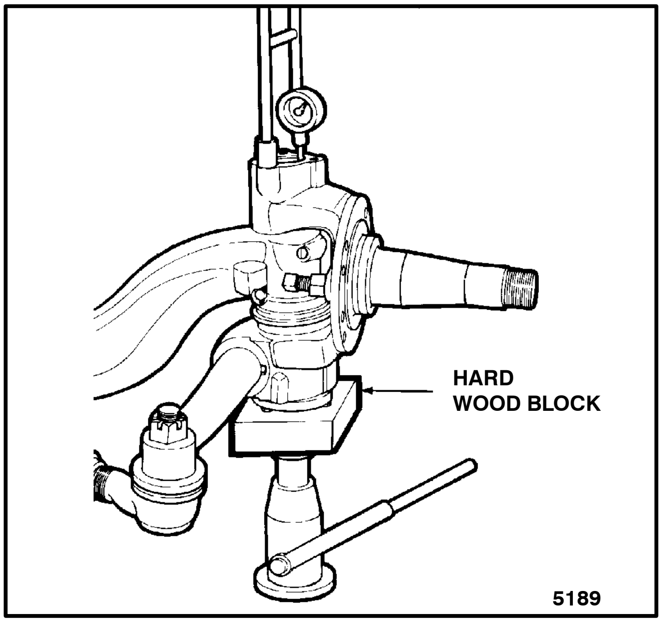


Figure 22. Lifting Knuckle With Jack

A small hydraulic jack under a block of wood can be used beneath the knuckle to provide the necessary lift. Keep lifting the knuckle until the dial indicator reading levels off (Figure 22).

WARNING

When using a hydraulic jack, be sure that the axle is supported by two jack stands. Raising the end in this manner may cause an axle supported only in the center to tip and fall, causing personal injury.

5. Repeat steps1 thru 4 with the knuckle in the full right and left turn positions. This is necessary to be sure that no binding or excessive play is present.

NOTE: If binding exists or zero end play is measured anywhere in the full travel of the knuckle, remove shims as required to obtain end play of 0.001-0.025-inch. After measuring knuckle clearance (end play) of over 0.025-inch, add shims between upper knuckle pin boss and axle center end, as required, to obtain an end play of 0.001-0.025-inch (0.02-0.64 mm) through full range of turn. Normal seating of the thrust bearing, seal and shims will increase the end play reading after a short time in service.

Procedure 2

1. Securely block vehicle to prevent rolling.
2. Place a jack under the axle beam as close as possible to the knuckle end being checked and jack the vehicle up until the tire is clear of the floor.

NOTE: Attach a dial indicator to the axle beam with a "C" clamp or magnetic base (Figure 23).

3. Place the dial indicator plunger on top of the knuckle pin cap or knuckle forging so than its line of action is approximately parallel to the knuckle pin center line.
4. Zero the dial indicator
5. Measure the knuckle clearance (end play) by using a suitable lever to lift the knuckle while observing the dial indicator. Make a note of the measurement.

WARNING

In service axle end play may increase to a maximum of 0.065-inch (1.70 mm) at which time it will be necessary to re-shim end play back to 0.001 - 0.025-inch (0.02 - 0.64 mm).

If a reading of over 0.065-inch is taken, remove the tire and knuckle pin cap and remeasure as per procedure #1. If the reading is still over 0.065-inch, then re-shim to specifications.

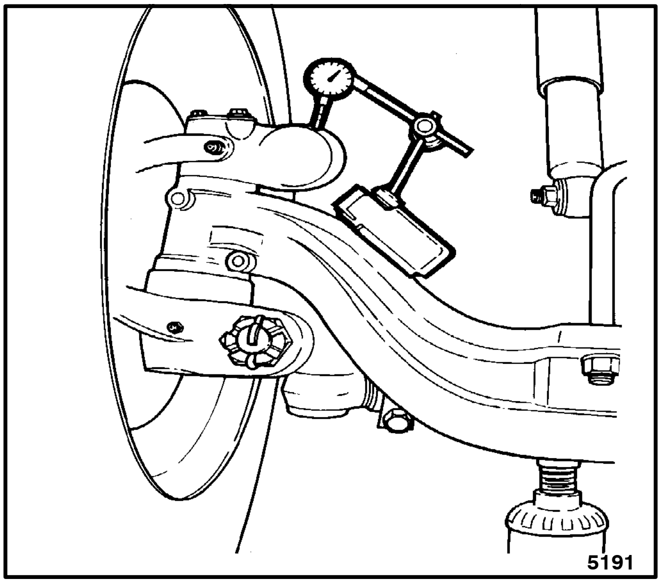


Figure 23. Dial Gauge Installed

Tie Rod Assembly

The tie rod assembly connects the two axle knuckles together. It is constructed of a center cross tube and two non-repairable end assemblies. The rod is threaded on each end as are the rod ends which are held on additionally by clamps. (Figure 24)

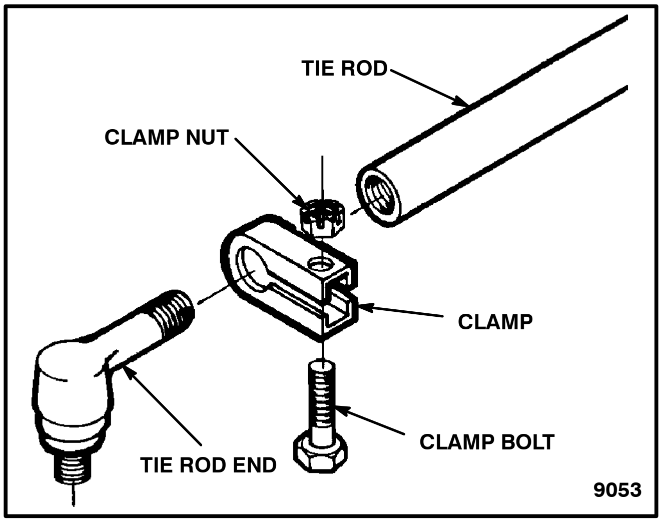


Figure 24. Tie Rod Assembly

Socket wear in the non-repairable end assemblies is indicated by ball stud turning torque and socket end movement. End movement may be checked with the socket assembly attached to its mating arm. New socket assemblies should have an end movement of not more than 0.020 inches (0.508 mm). Maximum allowable end movement on worn sockets is 0.090 inches (2.28 mm).

To check the turning torque value between the tie rod end assembly stud and the ball cavity, the socket must be removed from the vehicle. Minimum allowable torque value is 5 in.lbs. (0.565 N·m).

END REMOVAL

1. Remove cotter pin and unfasten nut attaching end to the tie rod arm.
2. Using a small drift, rap the side of the tie rod end to loosen, and remove from tie rod arm.
3. Loosen clamp bolts and unthread tie rod ends from the cross tube.

END INSTALLATION

1. Thread new tie rod end into the cross tube, until the tie rod end's tappered stud will slip into the tie rod arm.
2. Tighten clamp bolts to 55-60 ft-lbs torque (75-88 N·m).
3. Attach and tighten tie rod end-to-arm hex nut to 165-180 ft-lbs torque (224-244 N·m), and insert new cotter pin.
4. Lubricate new tie rod end, and check alignment.

TRAILING AXLE ALIGNMENT

Correct trailing axle alignment must be maintained for ease of self-steering and satisfactory tire life. Road shock, vibrations, normal stresses and strains set-up in the trailing axle under average operation can result in loss of alignment.

If incorrect trailing axle alignment is suspected, trailing wheel balance should first be checked to make sure that the difficulties are not originating from out-of-balance wheels. A check of the inflation, wheel installation and runout, wheel bearing adjustment, tie rod end wear should also be made.

Correct alignment can only be maintained when all parts in the trailing axle's steering geometry are in satisfactory condition.

Factors of correct alignment are as follows:

1. **TRAILING WHEEL CAMBER**: The amount the wheel leans outward "Positive Camber" or inward "Negative Camber" from the vertical plane, usually measured in degrees. All coach axles have "Unbiased" or equal camber.

NOTE: Axles are 1/4 degree "Positive Camber" in the unloaded condition, but may exhibit "Negative Camber" in some loaded conditions.

2. **TRAILING WHEEL TOE-IN**: The distance the wheels are closer together at the front than at the rear.

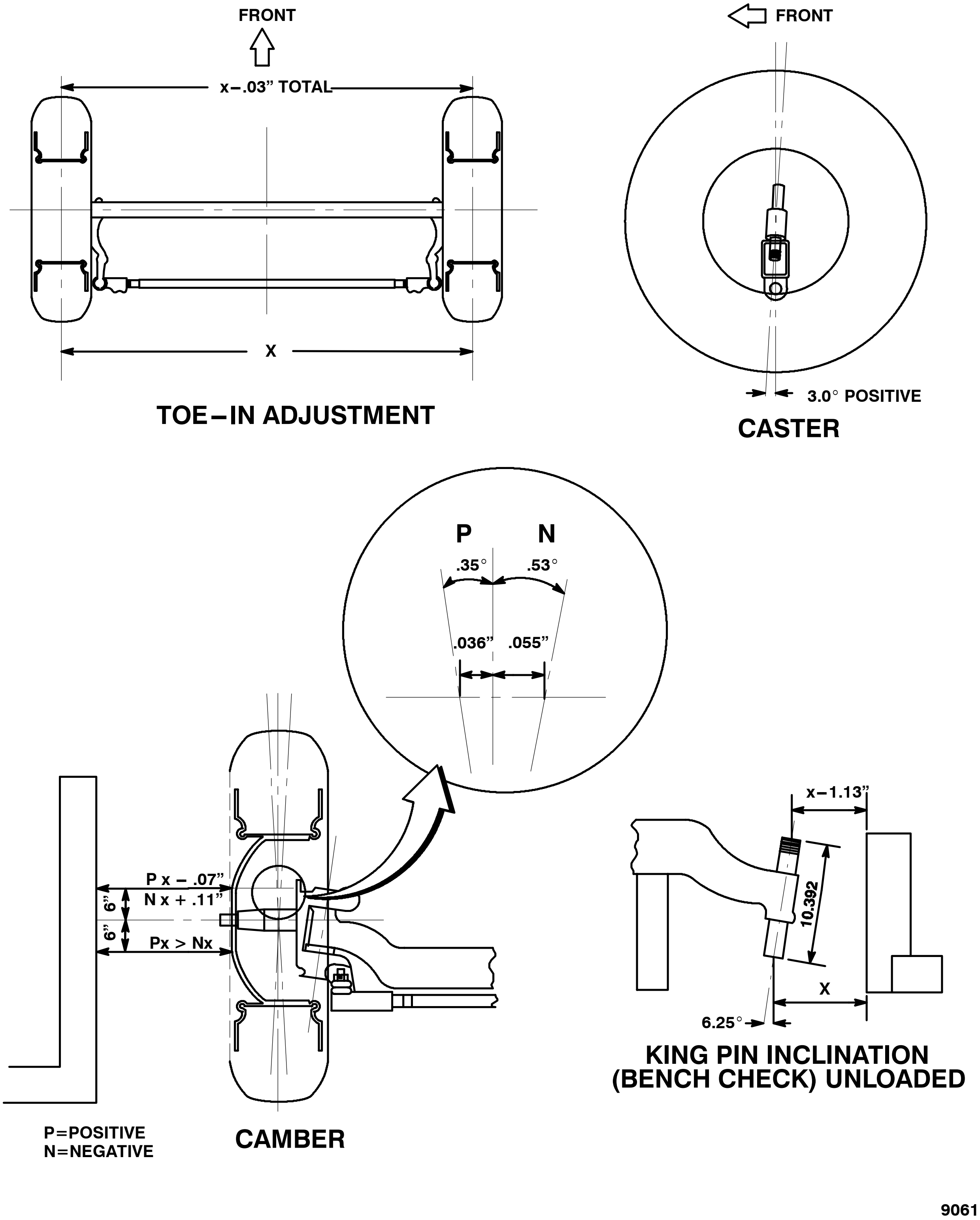

FRONT
x–.03" TOTAL
X
TOE–IN ADJUSTMENT
FRONT
3.0° POSITIVE
CASTER
P
N
.35°
.53°
.036"
.055"
P x – .07"
N x + .11"
6"
6"
Px > Nx
P=POSITIVE
N=NEGATIVE
CAMBER
x–1.13"
10.392
X
6.25°
KING PIN INCLINATION
(BENCH CHECK) UNLOADED
9061

Figure 25. Alignment Chart

3. **TRAILING AXLE CASTER**: The fore and aft inclination from vertical of the steering knuckle. “Positive Caster” is indicated with the top of the steering knuckle towards the rear of the vehicle. “Negative Caster” is indicated with the top of the steering knuckle towards the front of the vehicle. “Zero Caster” means no inclination of the steering knuckle. All axles used on coaches should have non-adjustable positive caster.

4. **KNUCKLE PIN INCLINATION**: The amount knuckle pins are inclined inward at the top. Knuckle pin inclination is non-adjustable.

5. **STEERING GEOMETRY**: The proper location and/or movement of the mechanical links that maintain the trailing wheels in proper alignment.

NOTE: All axles used on coaches have non-adjustable camber, caster and knuckle pin inclination angles.

⚠ WARNING ⚠

Any manipulation of or alteration to these axle characteristics could severely affect the axle’s steering geometry.

NOTE: Camber, caster and toe-in settings can be found in the alignment chart (Figure 25) and in ”Alignment Values” of the specifications at the end of this section

Checking Camber

Camber variations may be caused by wear at wheel bearings and steering knuckle bushings or by bent knuckle or sagging axle center.

Excessive positive camber results in irregular wear of tires at outer shoulders. Negative or reverse camber causes wear at inner shoulders. Ease of steering is also affected by any deviation from specified camber.

Position trailing wheels on turning plates in a straight ahead position. Attach alignment gauges to each wheel spindle. Record the camber readings for each wheel and compare with specifications at the end of this section.

Adjusting Toe-in

Incorrect toe-in results in excessive tire wear caused by side slippage. Unstable steering with a tendency to wander may also result. The following steps are to check and adjust toe-in:

NOTE: Make sure vehicle is on a level floor.

Do not measure toe-in with the trailing axle jacked up. The toe-in should be measured with the weight of the vehicle on the axle.

1. Lock self-steering feature in straight ahead mode, and jack up the trailing axle.
2. Use paint or chalk to contrast (white-out) the center tread area of both tires around their entire circumference.
3. Position a scribe or pointed instrument mounted on a steady fixture, against the contrast area of each tire and rotate the tires to scribe a base line reference mark.
4. Place a full-floating turning radius gauge plate under each wheel. Lower the vehicle and remove the lock pins from the gauge plates. If full-floating gauge plates are not available, lower the vehicle and move it backward and then forward approximately 6 feet (1.8m).
5. Position trammel bar at rear of tires and adjust pointer to line up with scribed reference lines and lock in place (scale should be set on zero). Pointers must be raised to spindle height on the tire (Figure 26).

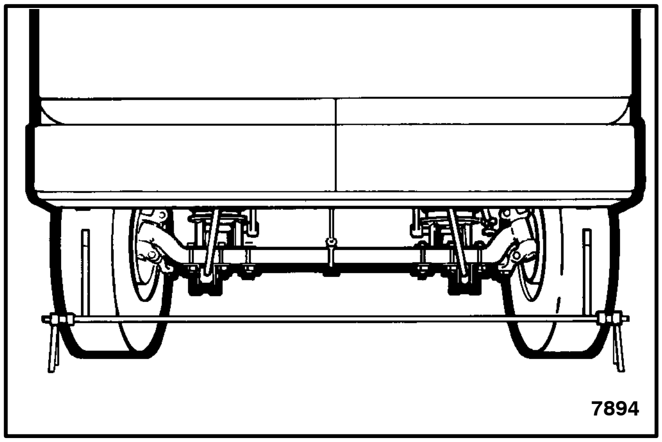


Figure 26. Trammel Bar With Pointers Set at Spindle Height

6. Position the trammel bar at the front of the tires. Adjust the scale end so that the pointers line up with the scribe marks.
7. Read toe-in or toe-out from the scale. Toe-in should read 0.03±0.03 inches (0.76±0.76 mm).
8. If adjustment is necessary, loosen the tie rod clamps and turn the tie rod as required, then re-tighten the clamps. If the vehicle is not on gauge plates, move it backward, then forward about 6 feet (1.8 meters).
9. Recheck the toe-in to ensure that it is correct.

Wheel Shimmy

In some extreme instances a coach may develop trailing wheel shimmy. The following is provided to assist maintenance personnel in determining the cause. If a shimmy condition is experienced, a procedure to eliminate the condition follows the inspection steps. Due to the large number of variables involved and the equipment needed to diagnose these variables, it is recommended that a reputable alignment shop perform the inspection and correction.

Inspection

Read and understand all steps prior to starting step one. Observe all standard and applicable safety standards.

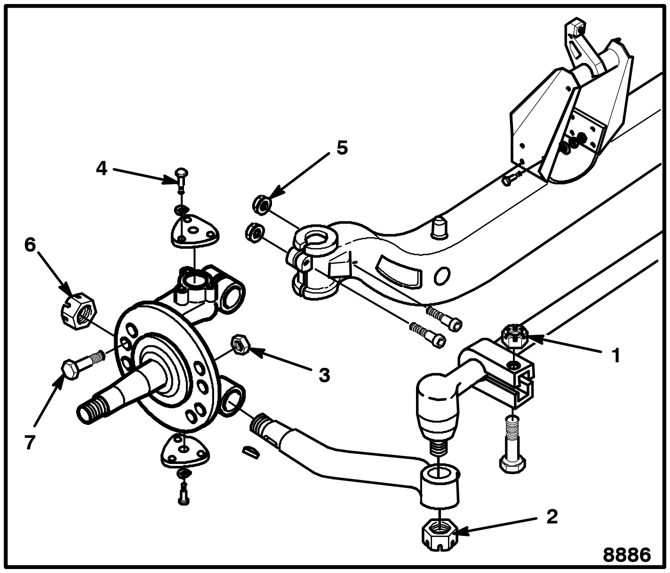
1. Check that all bolts and nuts are tight (i.e., suspension support stud nuts, U-bolt nuts, tie rod arm nuts, etc.) and that no damage or distortion has taken place. These should be checked and tightened (if necessary) to the torques given at the end of this section and Section 12.
2. Check the knuckle pin bushing for wear. If the bushings have 0.010 inches or more clearance, they should be replaced.
3. Check the tie rod ends for wear.
4. Check the radius rod bushings for wear.
5. Check the toe-in.
6. Check the hub balance.
7. Check the wheel balance.
8. Check the tires for out-of-round.
9. Check trailing axle caster. Excessive caster, in combination with some or all of the previous 8 items, and/or in combination with road conditions, can cause wheel shimmy. A recommended 3.0 degree caster angle is achieved with the lower radius rod mounting brackets
10. If caster angle is less than 2.0 degrees or more than 4.0 degrees contact customer service for further instructions.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Rapid or uneven tire wear.	A. Incorrect toe-in setting.	A. Check toe-in and reset as required. When setting toe-in, it is important to neutralize the component and tire deflections by backing up and then going forward and rechecking the toe-in. This is especially important with radial tires. The check and possible re-set should be followed even if bearing plates are used.
	B. Improper tire inflation.	B. Check tires for proper inflation.
	C. Unbalanced tires.	C. Check tire pressures.
2. Hard Tracking	A. Inadequate or improper lubrication of knuckle pins.	A. Lubricate knuckle pins and recheck steering.
	B. Improper Caster.	B. Check caster and set as required.
	C. Worn thrust bearing.	C. Check knuckle end play.
3. Rapid Wear of Cross Tube Ends	A. Inadequate or improper lubrication.	A. Check lubrication procedures and evaluate interval for possible revision. Check dust covers for tears.
	B. Severely contaminative environment.	B. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
	C. Failure of protective dust cover.	C. Inspect dust covers and replace ends where covers have failed
4. Bent or Broken Cross Tube, Broken Ball Stud, or Tie Rod Arm	A. Operational (curbing)	A. Check driving habits, refrain from impacting curbs.
6. Excessive Wear of Knuckle Pins and Bushings	A. Worn or missing seals and gaskets.	A. Check and rebuild to proper specifications.
	B. Improper type of grease.	B. Check lubrication specifications against lube being used. Ensure use of proper lube.
	C. Inadequate lubrication frequency.	C. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
	D. Improper lubrication technique.	D. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.

TROUBLESHOOTING (Contd.)

	E. Inadequate lubrication frequency due to extreme operating conditions such as abrasive dust and sandy environments.	E. Check lubrication procedures and evaluate interval for possible revision. Check dust cover for tears.
7. Trailing Axle Shimmy or Vibration	A. Incorrect master setting.	A. Check alignment and correct as necessary.
	B. Wheels and/or tires not properly balanced.	B. Check tire balance and adjust as required.
	C. Worn shock absorbers.	C. Replace shocks.



TORQUE SPECIFICATIONS

1. Tie Rod End Clamp Bolt Nuts	40-60 ft-lbs (54-81 N·m)
2. Tie Rod Arm to Tie Rod End Stud Nuts	160-300 ft-lbs (216-406 N·m)
3. Stop Screw Locknut	50-65 ft-lbs (68-88 N·m)
4. King Pin Cap Capscrews	20-30 ft-lbs (28-40 N·m)
5. Draw Key Nut	30-45 ft-lbs (41-61 N·m)
6. Tie Rod Arm to Knuckle Nut	550-1025 ft-lbs (746-1389 N·m)
7. Spider to Knuckle Capscrew (8-Bolt Pattern)	180-240 ft-lbs (244-325 N·m)

SPECIFICATIONS

AXLE CENTER

Manufacturer	Rockwell International
Part Number	2L-6-78
Design	(Reverse Elliot) Tubular
Allowable Twist (Variation Between Ends)	0.5 Degree

STEERING KNUCKLES

Spindle Diameter: Inner Bearing	2.625-2.624 in. (66.662-66.637 mm)
Spindle Diameter: Outer Bearing (Disc)	1.750-1.749 in. (44.441-44.415 mm)
Up-And-Down Movement	0.005-0.065 in. (0.127-1.65 mm)
Bushing Bore Diameter	1.9019-1.921 in. (48.743-45.657 mm)

STEERING KNUCKLE BUSHINGS

Type	"Easy Steer"
Ream Diameter	1.796-1.795 in. (45.618-45.593 mm)

KNUCKLE PIN

Type	Straight
Diameter	1.794-1.793 in. (45.568-45.542 mm)

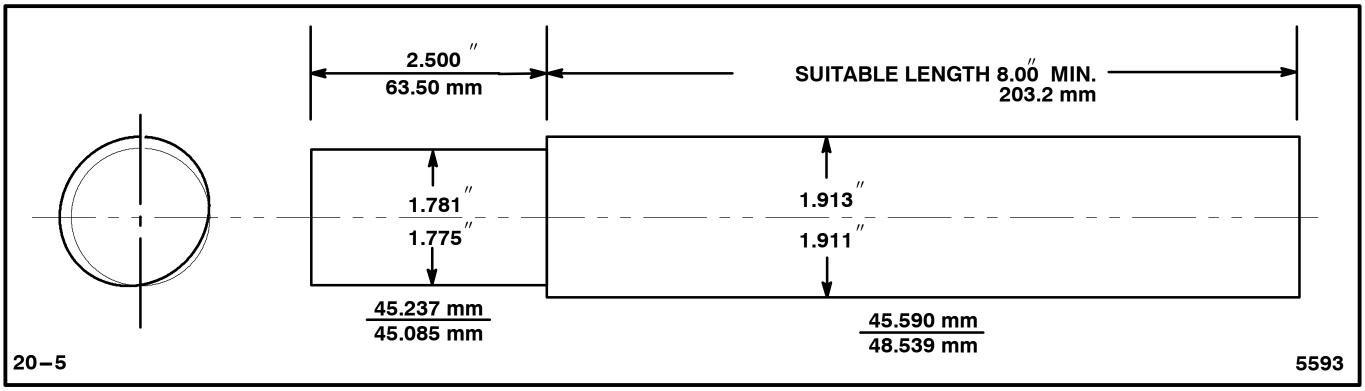
ALIGNMENT VALUES (LOADED)*

Camber	(Acceptable Range) -.53-.35 Degree
Caster	3.0 Degrees (Positive)
Toe-In (Adjustable)	.0.03 inches Total (± .03 inches) (0.76±0.76 mm)
Trailing Axle Track:	85.6" (2.17 m)

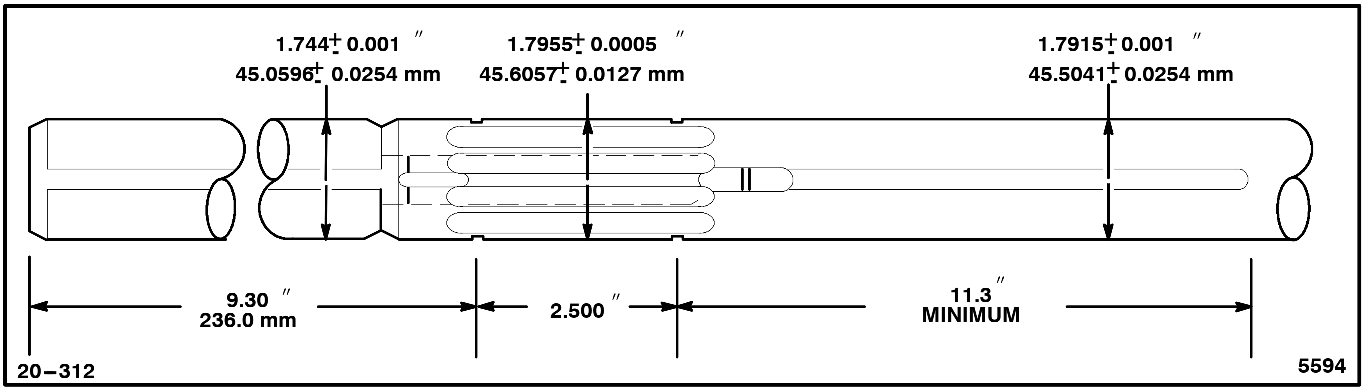
* Note: Based on empty coach front axle weight of 10,000 lbs.

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.


2.500″
63.50 mm
SUITABLE LENGTH 8.00″ MIN.
203.2 mm
1.781″
1.775″
1.913″
1.911″
45.237 mm
45.085 mm
45.590 mm
48.539 mm
20−5
5593

20-5 Tool - King Pin Bushing Removal & Installation


1.744± 0.001″
45.0596± 0.0254 mm
1.7955± 0.0005″
45.6057± 0.0127 mm
1.7915± 0.001″
45.5041± 0.0254 mm
9.30″
236.0 mm
2.500″
11.3″
MINIMUM
20−312
5594

20-312 Tool - King Pin “Easy Steer” Bushing Reamer

SECTION 2B2

TRAILING AXLE - PIVOTING ARM (MODEL 102D3)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	2B2-1
Components	2B2-1
Maintenance	2B2-1
Torque Specifications	2B2-3
Specifications	2B2-4

GENERAL DESCRIPTION

This coach model features a liftable arm type trailing axle independently mounted at the rear of the drive axle. The trailing axle design replaces the standard trailing axle crosstube with left and right trunnion-arm bearing box mounting assemblies. The trailing axle trunnion arm pivots in two sets of roller bearings inside each of their respective mounts. The bearing boxes are bolted to the rear bogie leg mounting plate.

The pivot action allows trailing axle wheels to track while traveling forward or backing. The trailing axle will use different brake components than what is currently being used with front axle drum brakes, and will offer both drum and disc brake configurations. The trailing axle hub assemblies are available in an oil lubricated version only.

COMPONENTS

The right and left hand trailing axle assemblies are each composed of a welded axle arm with machined spindle and trunnion attached, bogie leg bearing box mount and heavy roller bearing assemblies. In addition, trailing axle brake assemblies and hub assemblies are fitted to complete the trailing axle assembly (Figure 1).

The bearing box mounts are filled with lube oil, and sealed by axle arm at one end and flange cover at the other end. The trunnion spindle is machined in a step fashion to accept bearing assemblies, and welded to the axle arm at the other end. The axle arm trunnion and bearings are retained in the bearing box mount by a spanner locknut and tongue washer.

NOTE: Further information on brake assemblies (Section 4) and hub assemblies (Section 15) can be found in their respective sections. Air suspension bellows, shock absorbers and control systems information can be found in Section 12D & 12E.

MAINTENANCE

LUBRICATION

Trailing axle trunnion bearings are splash feed, and oil levels should be checked every 25,000 miles (40,200 km). The oil should be changed when contaminated, or seal replacement is performed. Using lubrication specification S-9 thru S-12 (Mutli-Purpose Gear Oil), lube the trailing axle trunnion bearings per step 4 of “Axle Installation” procedure.

⚠ WARNING ⚠

Excessive bearing end play could result in premature seal and/or bearing failure.

A periodic inspection of all trailing axle arm seals and bearings should be made every 100,000 miles (160,900 km). If excessive trailing axle arm end play exists, re-torque the trunnion bearing locknut as specified in step 3a or 3b of the “Axle Installation“ procedure.

NOTE: Two different styles of trunnion spindle locknut arrangements having different torque requirements have been used on the trailing axle bearing boxes. Effective with #47137 locknuts with nylon insert were replaced with spanner nut and tongue washer.

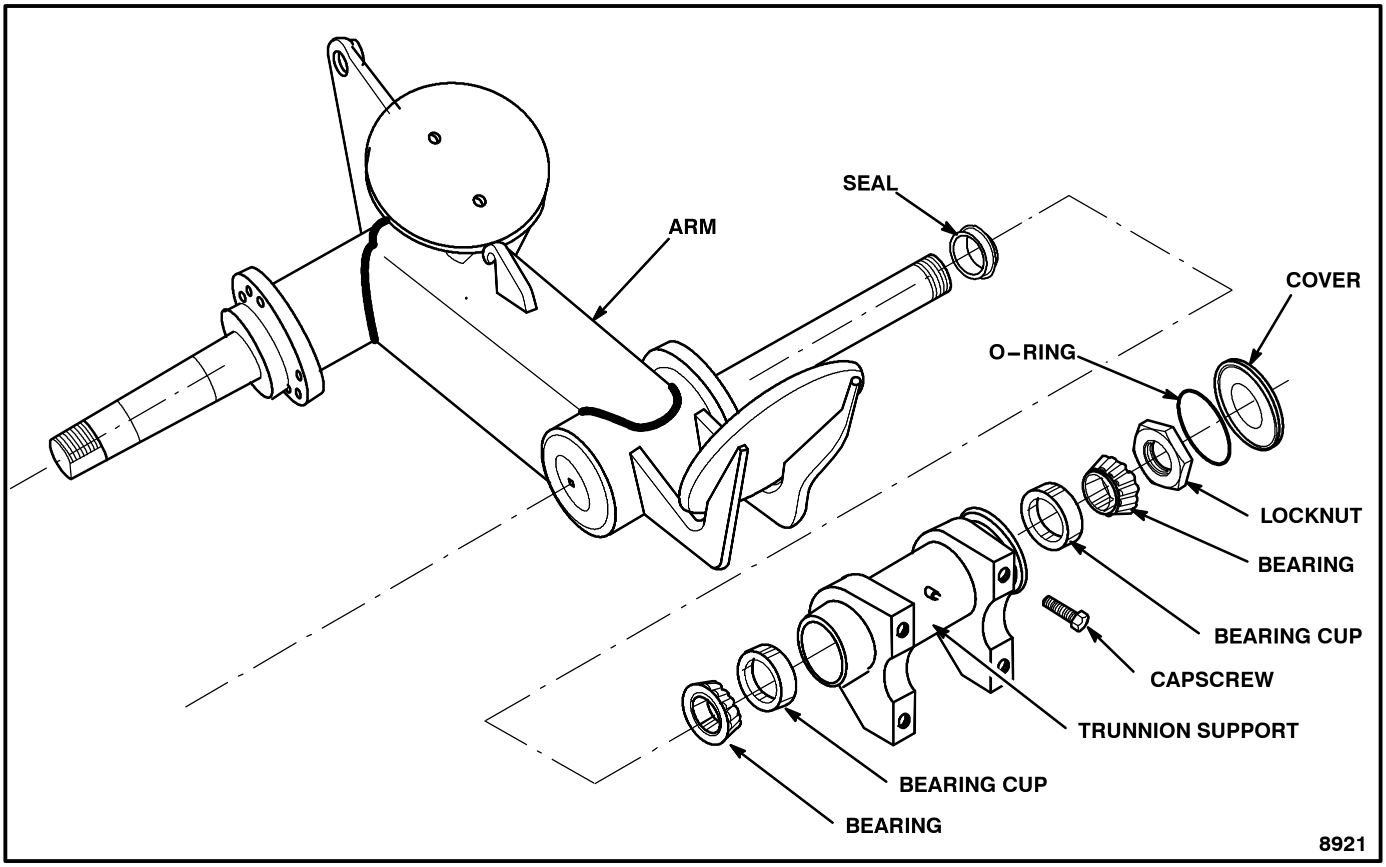


Figure 1. Trailing Axle Assembly

AXLE ARM REMOVAL

1. Turn the main disconnect switch to “OFF”, block the coach from moving and remove the trailing axle tire and wheel assembly per the “Removal” procedure.
2. Drain all air from the suspension and service brake tanks, and disconnect lines from trailing axle suspension and lift actuator bellows air fittings. and brake chamber air fittings.
3. Disconnect lines from trailing axle brake chamber air fittings.
4. Disassemble the trailing axle drum or disc brake assemblies per their applicable “Removal” procedures.
5. Unfasten and remove the hub cap assembly and drain the bearing lube oil from hub.
6. Unfasten and remove hub locking nut, and slide hub or hub and rotor assembly including bearings and seals off axle arm spindle.
7. Unfasten and remove brake spider or torque plate from axle arm mounting plate.
8. Unfasten and remove both the lifting and suspension bellows from the axle arm and chassis mounting pads.
9. Unfasten and remove shock absorber assembly.
10. After placement of a suitable bearing lube oil catch, unfasten and remove trunnion bearing box inner seal cover plate.
11. With axle arm adequately supported, remove the trunnion retaining locknut or spanner nut and tongue washer.
12. Remove inner bearing and gently slide axle arm out of bearing box mount.
13. Remove outer bearing from trunnion shaft.

BEARING BOX REMOVAL

1. Unfasten outer slinger shield from bearing box and remove.
2. Grind tack weld from lower bearing box mounts.

NOTE: Cracked tack welds could indicate movement of the bearing box. Trailing axle toe-in and camber adjustment should be checked when welds have cracked.

3. Unfasten capscrews and remove bearing box from bogie leg mounting plate.
4. Remove bearing journals and seals from bearing box if damaged or worn.

BEARING BOX INSTALLATION

1. Install new bearing journals and seals into the bearing box.

2. Mount bearing box onto bogie leg and leave mounting capscrews loose.

3. Reset axle toe-in adjustment (.06” ± .06”) using bogie leg mounting plate jackscrews. Shim as required and tighten capscrews enough to retain setting.

4. Reset axle camber angle adjustment (.25° positive ± .44°) by moving bearing box against the mounting plate and torque capscrews to 315 ft-lbs (426 N·m).

5. Tack weld 1/8” on bottom bearing box legs to retain settings.

6. Reattach outer slinger shield to bearing box.

AXLE ARM INSTALLATION

1. Install outer bearing box oil seal and bearing onto trunnion.

2. Coat machined surfaces with lube oil, and with axle’s outer arm supported insert trunnion spindle through bearing box.

NOTE: Make sure that outer bearing box oil seal is properly seated in bearing box running surface.

3. Use torque procedure (3a) on locknut with nylon insert (prior to unit #47137). Use procedure (3b) on spanner nut and tongue washer (effective with unit #47137).

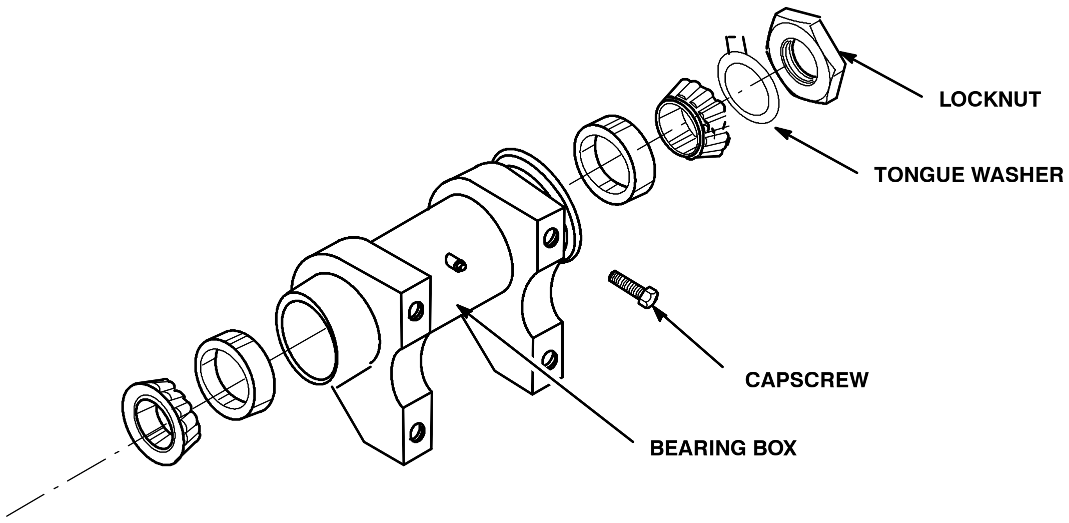
a. Install flatwasher and jam nut onto trunnion end. Torque nut to 150 ft-lbs (203 N·m), loosen and retorque in steps to 130 ft-lbs (176 N·m) while rotating the axle arm.

b. Install tongue washer and spanner locknut onto trunnion end. Torque nut to 100 ft-lbs (135 N·m), loosen and retorque to 30 ft-lbs (40 N·m) while rotating the axle arm.

NOTE: Do not use positive locking hex nuts that require staking onto the trunnion spindle threads.

4. Reverse steps 1 thru 10 of the “Removal” procedure, and refill bearing box with lubricating oil to proper level.

TORQUE SPECIFICATIONS



1. BEARING BOX CAPSCREW TORQUE 315 ft.lbs. (426 N•m)
2. LOCKNUT W/NYLON INSERT TORQUE 130 ft.lbs. (176 N•m)
2. SPANNER NUT W/TONGUE WASHER TORQUE 30 ft.lbs. (40 N•m)

8921

SPECIFICATIONS

TRAILING AXLE ARM

Manufacturer	MCI
Type	Pivoting Arm
Camber Angle	(.255 positive + .445)
Toe-In	(.06” + .06”)
Part Number (Basic Used Prior To Unit #47137)	2L-6-242 LH
Part Number (Basic Used Prior To Unit #47137)	2L-6-243 RH
Part Number (Liftable Used Prior To Unit #47137)	2L-6-252 LH
Part Number (Liftable Used Prior To Unit #47137)	2L-6-253 RH
Part Number (Basic Effective With Unit #47137)	2L-6-337 RH
Part Number (Basic Effective With Unit #47137)	2L-6-338 LH
Part Number (Liftable Effective With Unit #47137)	2L-6-342 RH
Part Number (Liftable Effective With Unit #47137)	2L-6-343 LH

BEARING BOX

Manufacturer	MCI
Type	Oil Lubed
Part Number (Used Prior To Unit #47137)	2L-6-138
Part Number (Effective Unit #47137)	2L-6-327

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 3

BODY

This section consists of six primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The six primary subsections are:

A - Body Structure
B - Interior Components
C1 - Exterior Components
C2 - Windshield Wipers/Washers & Exterior Mirrors
D1 - Entrance Door and Retractable Step
D2 - Baggage & Service Compartment Doors & Escape Hatches
E - Windshields, Window Glass & Glazing
F - Lifting and Towing

SECTION 3A

BODY STRUCTURE

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 3A-1
Components 3A-1
Maintenance 3A-3
Specifications 3A-7

GENERAL DESCRIPTION

The 102 D series coach body structure utilizes a modified monocoque design. The design mates a light upper body framework to a more rigid lower frame and suspension sub-structure. Interior and exterior panels are then mechanically fastened or welded to the frames.

The panels along with various mounting extrusions help rigidify the frame structures. This type design and construction allows both frame and panels to evenly distribute and carry normal coach loads and stresses providing a light weight, yet extremely strong body structure (Figure 1).

This section will address the procedures for the repair and/or replacement of frame members or components. General and specific interior and exterior panel replacement instructions will also be discussed.

COMPONENTS

FRAMES & SUB-STRUCTURE

Frames are fabricated from stainless steel and high-strength, low-alloy (Cor-Ten) type carbon steels. Frame members consist of square steel tube, hat channels or formed structures. Frame are precision jigged and welded using the AWS welding codes. The upper and lower frame assemblies are joined together at the belt rail.

The lower frame assembly consists of three separate frame. A rear lower frame, a center lower frame and a front lower frame are joined together to create a complete lower frame assembly (Figure 2). The lower front and center frames are constructed of stainless steel members, while the lower rear frame and suspension sub-structures are fabricated from high strength, low-alloy steel, which are coated with primer after welding.

The lower frame incorporates integral front and rear suspension sub-structures (bogies) welded into the front and rear lower frames. Twin front trusses and engine support rails extend from front and rear sub structures to the end of these frames. A central tunnel assembly along with the return air ducts spans the length of the center frame providing mounting for air, fuel, hydraulic, heating & A/C piping and electrical harnesses (Figure 3). These features create a rigid center spine the length of the coach, and together with stainless bulkheads, trusses and underbody skid rails, they provide additional lower frame strength.

The upper frame assembly consists of five separate frames. A roof frame, A rear upper frame, a LH/RH sidewall frame and a front upper frame are joined together to create the complete upper frame structure (Figure 4). The upper frames are constructed completely of high-strength, low-alloy type steel members.

PANELS & EXTRUSIONS

Coach exterior skin panels are made from fiberglass, pre-painted aluminum, stainless and electro-galvanized sheet steel. Interior finishing panels are made from Melamine, fiberglass stainless steel and vinyl covered aluminum. Panel mounting and molding extrusions are manufactured from aluminum.

Paintable T409 steel panels are used on all rear service and access doors, lower fixed panels at rear and along side wheelhouse openings. Aluminum roof panels are .052 thick, while panels below the belt rail on service and baggage doors are .064 thick. The galvanized steel sidewall panels are .051 thickness. Front lower cap, windshield revels and front and rear roof caps are 1/8 inch thick pressure molded fiberglass. Optional brush finished T 304 20 gauge stainless steel fluted and flat panels are available below the belt rails, over the front cap and on the rear of coach.

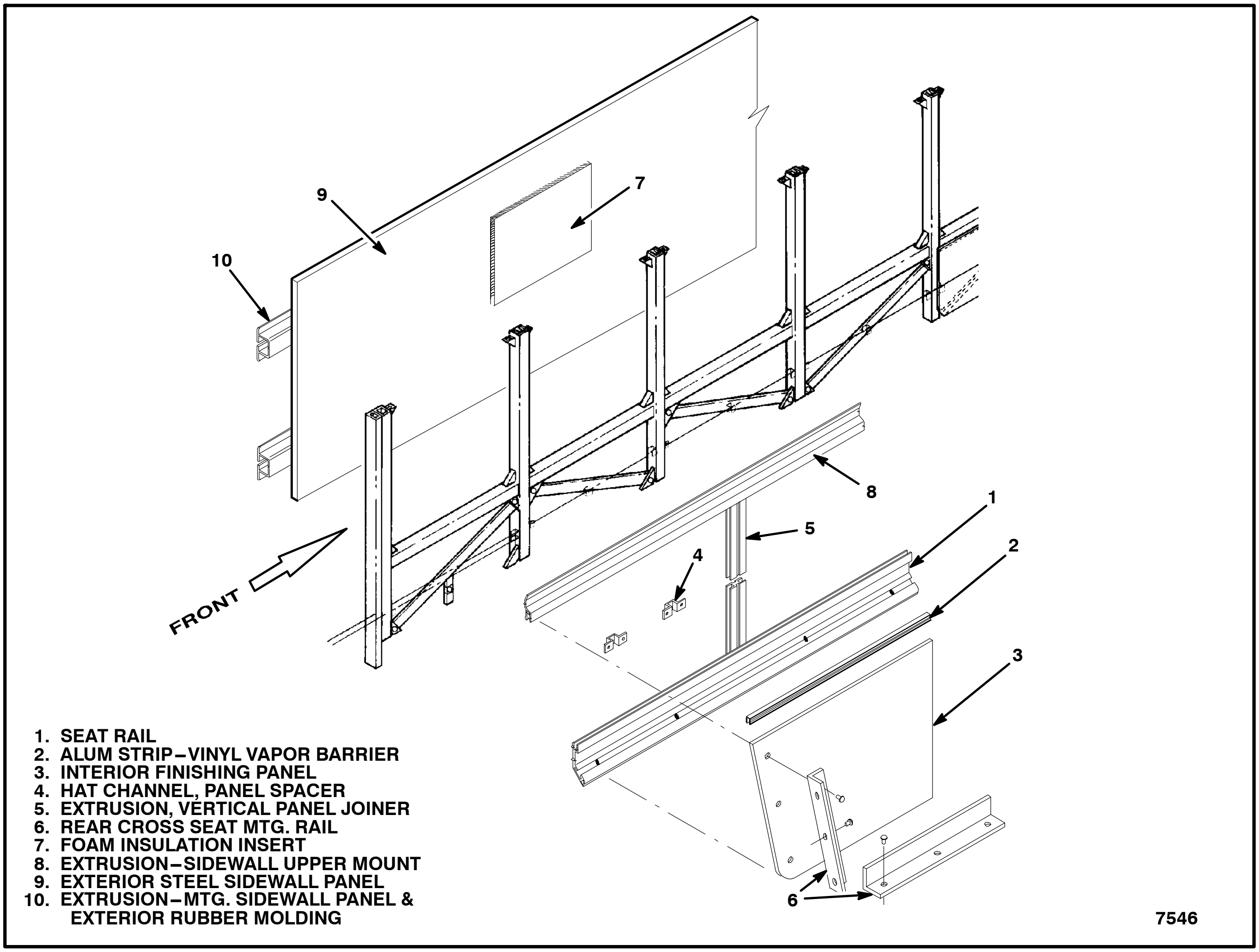

9
7
10
8
1
5
2
4
3
FRONT
6
1. SEAT RAIL
2. ALUM STRIP–VINYL VAPOR BARRIER
3. INTERIOR FINISHING PANEL
4. HAT CHANNEL, PANEL SPACER
5. EXTRUSION, VERTICAL PANEL JOINER
6. REAR CROSS SEAT MTG. RAIL
7. FOAM INSULATION INSERT
8. EXTRUSION–SIDEWALL UPPER MOUNT
9. EXTERIOR STEEL SIDEWALL PANEL
10. EXTRUSION–MTG. SIDEWALL PANEL & EXTERIOR RUBBER MOLDING
7546

Figure 1. Typical Body Construction

Upper sidewall frame structural panels are fabricated from high-strength, low-alloy steel. Front stainless and rear (Cor-Ten) bulkhead panels close the lower frame's interior area. Intermediate aluminum bulkhead panels are provided between the baggage compartments, and separate the HVAC blower, condenser and fuel compartment areas.

Underbody panels such as the corrugated aluminum floors of the baggage area, cover panels on the center tunnel and baggage bay ceilings, motor and tire compartment floors, rear cross seat panels and interior plywood floorboards add strength to frame structures.

Exterior extruded aluminum belt and sash rails and drip rails extend along the sides of the coach above and below the windows. Interior extruded aluminum sidewall seat rails and formed stainless steel heat duct panels mounted to the sidewalls and floorboards add upper frame rigidity and strength.

Mechanical attachment of panels and extrusions to framework utilize threaded, bucked and pop riveted fastening systems. Dissimilar metals are separated by mastic, foam or mylar tapes. Exterior panel joints are weather sealed with aluminum pigmented epoxy sealants and mastics.

INSULATION

Roof and sidewall panels are insulated with 2-inch (51 mm) medium density spun fiberglass blanket or high density rigid board insulation. Additional insulation is used for noise and heat loss reduction at the rear cross seat engine compartment areas, top voids of bogies structures over axles and optionally around the stepwell and driver's areas. A thin fiberglass sheet thermal stop and a vinyl film vapor barrier are installed the length of the sidewalls floor to sash.

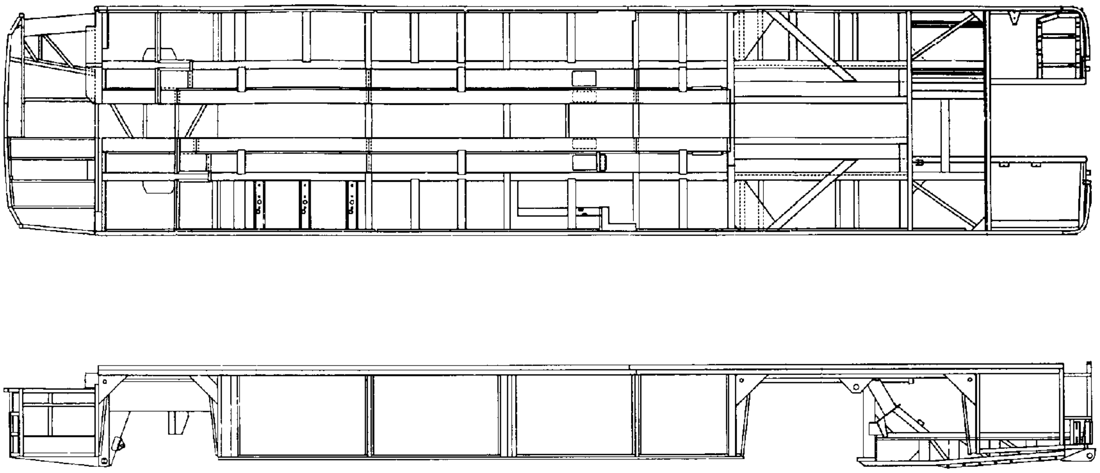


Figure 2. Lower Frame Structure

PAINT & COATINGS

The upper and lower frame assemblies are finish painted with one coat of grey acrylic enamel including inner panels and bulkheads. Suspension sub-structures receive one finish coat of chassis black polyurethane enamel. The sub-structures and entire underside panels and skid rails from the engine rails forward are sprayed with a heavy application of tectyl silver undercoating.

MAINTENANCE

CORROSION PREVENTION

Corrosion can be a major cause of damage to the body. Preventive maintenance is a key factor in avoiding corrosion to frames and underbody panels. The following steps may help in preventing corrosion damage.

A. Periodic inspections for frame and/or panel corrosion should be made part of the regular service and inspection intervals.

B. The coach body has been specially painted and undercoated to resist corrosion. These coatings should be kept intact for proper corrosion resistance.

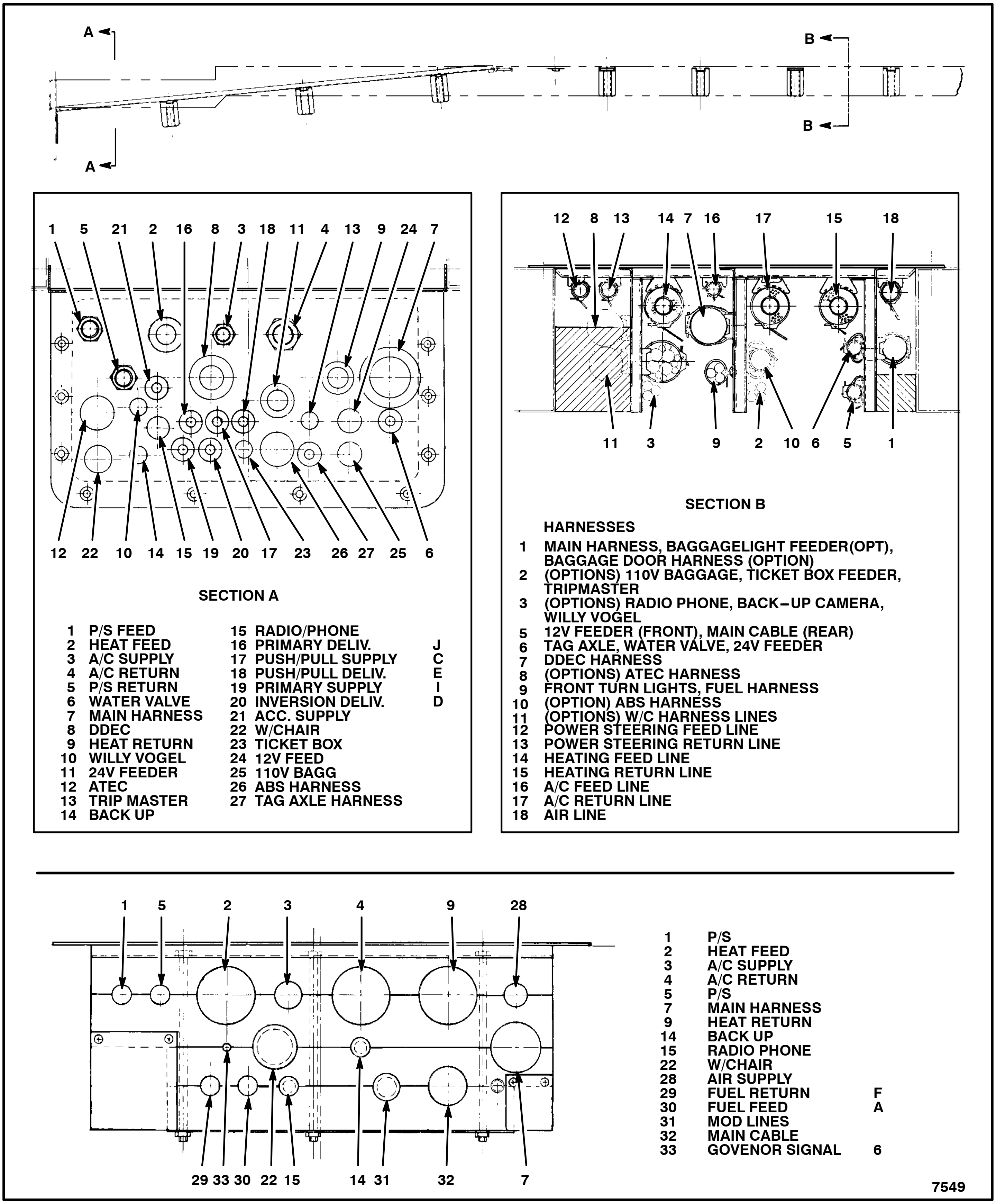
C. Always inspect the coach after accidents or other damage has occurred to determined if a reapplication of these coatings are required.

IMPORTANT: Failure to properly maintain the coach lower body surfaces and structural components may void the coach warranty.

If corrosion is found to be present, power wire brushing of the affected areas may be used to prepare them for reapplication of coatings. A light sandblasting or brushblast may be required to properly clean the areas. Extremely corroded frame members and structural components should be cut out and replaced.

⚠ CAUTION ⚠

A light brush blast can be used for cleaning corroded areas of stainless and carbon steel frames, trusses, bulkheads, sub-structures, brackets and other structural members. It should not be used for cleaning the exterior skin panels. Use extreme care when sandblast coach body components.



SECTION A

1	P/S FEED	15	RADIO/PHONE	
2	HEAT FEED	16	PRIMARY DELIV.	J
3	A/C SUPPLY	17	PUSH/PULL SUPPLY	C
4	A/C RETURN	18	PUSH/PULL DELIV.	E
5	P/S RETURN	19	PRIMARY SUPPLY	I
6	WATER VALVE	20	INVERSION DELIV.	D
7	MAIN HARNESS	21	ACC. SUPPLY	
8	DDEC	22	W/CHAIR	
9	HEAT RETURN	23	TICKET BOX	
10	WILLY VOGEL	24	12V FEED	
11	24V FEEDER	25	110V BAGG	
12	ATEC	26	ABS HARNESS	
13	TRIP MASTER	27	TAG AXLE HARNESS	
14	BACK UP			

SECTION B

	HARNESSES
1	MAIN HARNESS, BAGGAGELIGHT FEEDER(OPT), BAGGAGE DOOR HARNESS (OPTION)
2	(OPTIONS) 110V BAGGAGE, TICKET BOX FEEDER, TRIPMASTER
3	(OPTIONS) RADIO PHONE, BACK–UP CAMERA, WILLY VOGEL
5	12V FEEDER (FRONT), MAIN CABLE (REAR)
6	TAG AXLE, WATER VALVE, 24V FEEDER
7	DDEC HARNESS
8	(OPTIONS) ATEC HARNESS
9	FRONT TURN LIGHTS, FUEL HARNESS
10	(OPTION) ABS HARNESS
11	(OPTIONS) W/C HARNESS LINES
12	POWER STEERING FEED LINE
13	POWER STEERING RETURN LINE
14	HEATING FEED LINE
15	HEATING RETURN LINE
16	A/C FEED LINE
17	A/C RETURN LINE
18	AIR LINE

1	P/S	
2	HEAT FEED	
3	A/C SUPPLY	
4	A/C RETURN	
5	P/S	
7	MAIN HARNESS	
9	HEAT RETURN	
14	BACK UP	
15	RADIO PHONE	
22	W/CHAIR	
28	AIR SUPPLY	
29	FUEL RETURN	F
30	FUEL FEED	A
31	MOD LINES	
32	MAIN CABLE	
33	GOVENOR SIGNAL	6

Figure 3. Central Tunnel for Tubing and Harnesses

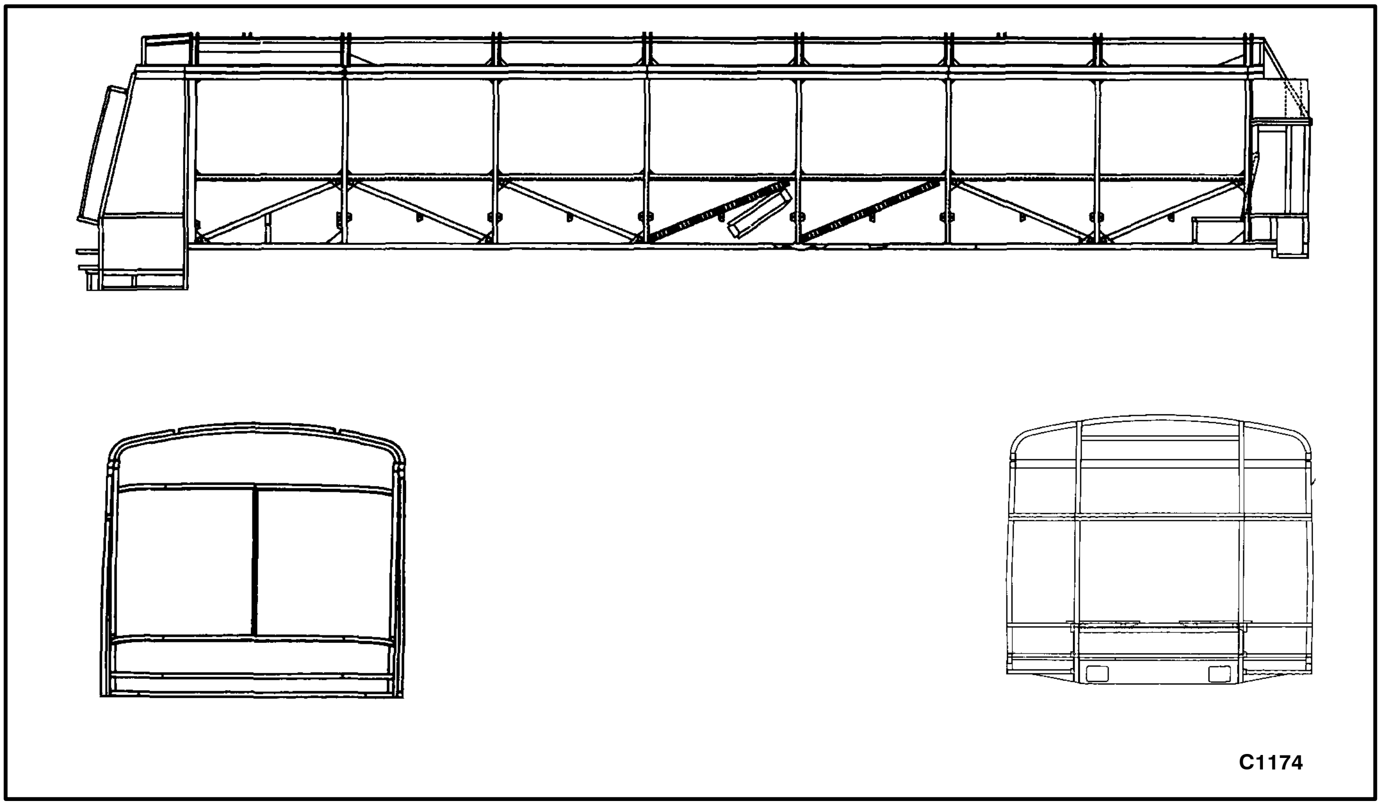


Figure 4. Upper Frame Structure

STRUCTURAL WELDING

Frame components may be manually welded with either the wire feed or stick welding processes. Fillet or full penetration butt welding (with or without back-up) is the preferred method of attachment. Gas welding or brazed repairs are not recommended, and should never be performed on load bearing components.

IMPORTANT: All welding must conform to D1.1 of the AWS Structural Steel Welding Specifications and/or Codes.

NOTE: Refer to the welding rods applications table at the end of this section when making welding repairs to the body structure.

CAUTION

Refer to the "Welding Caution" in the introductory pages of this manual before starting any welding operation.

FRAME REPAIRS

Suspension Sub-Structures

These components are typically the front and rear bogie frames. Additional components include the suspension supports and axle retaining components.

NOTE: The suspension sub-structures are precision jig welded to ensure proper alignment and correct radius rod attaching points. Straightening or major welded repairs to these sub-structures are not recommended. Extreme care should be taken when fitting and welding these structures to other framework.

Upper & Lower Frame Assemblies

1. Block or otherwise properly support coach and/or coach components. Turn main battery disconnect to off, and disconnect any other applicable components as specified in the welding caution.

2. Unfasten and remove panels and doors covering the area to be repaired.

3. Remove any insulation and thoroughly clean any sealants or mastics from cutting areas. Mark the damaged frame areas to be cut and removed.

4. Saw or flame cut the damaged members or section from the frame assembly.

5. Grind smooth any remaining stub and the surrounding weld area.

6. Fit and clamp the new members or section and weld in place. Grind flush any frame welds contacting door seals.

NOTE: Bent frame members adjacent to the new members may now be straightened. Shims may be required on some areas of old and new frame members to properly mount panels.

7. Reinstall new panels using the following instructions and/or the general “Panel Replacement” procedures found in Section 3C of this manual.

Central Tunnel

The central tunnel and HVAC return air ducts run under the center aisle of the coach. Coach electrical, mechanical and hydraulic systems are contained within this tunnel.

CAUTION

Due to the close proximity of harnesses and tubing to the aisle floorboard, Do not drill any holes in the center aisle. This area is 15 inches wide and runs the length of the coach.

Access to the central tunnel can be made from inside the passenger compartment by removal of the center aisle ramp assembly. Other access along the length of the tunnel is made through the baggage compartment ceiling panels.

PANEL REPLACEMENT

Several different panel attaching methods are used to affix interior and exterior panels. Most panels will be retained by both mastics and rivets.

Sidewall Panel

1. Remove the sash and belt rail moldings from the retaining extrusions using the applicable “Removal” procedures in Section 3C of this manual.
2. Unfasten and remove front and rear vertical edge trim covering panel edges.

NOTE: The louvered panel and taillamp panel must be removed to access rear trim fasteners.

3. Unfasten and remove the sash and belt rail retaining extrusions. Match mark extrusions for reinstallation, and scribe a line denoting the rear edge of sidewall panel for locating new panel’s edge.
4. Drill out front and rear edge rivets and remove the sidewall panel from the coach.
5. Remove any excess sealants or mastics from the attachment areas.
6. Apply a new bead of sealant (P/N 21-7112-31) to the top, front and rear back edges. Apply a new bead of sealant (P/N 21-7112-38) around the top edges of the lower (Below Belt) panels covered by the bottom of sidewall panel.
7. Position the sidewall panel to the coach frame and align rear edge to scribed line. Align top edge to just below top of sash rail.
8. Fasten rear edge of panel to frame so it can be stretched tight for final riveting.
9. Heat panel to 150 – 170 degrees F°. to expand its length approximately .250 inches. Portable heaters can be used to heat the sidewall panel.

NOTE: The panel is stretched tight while expanded to prevent wrinkling after installation.

10. Starting from the rear, reinstall the sash and belt rail extrusions drilling new rivet holes between the old holes. Wipe any excess sealants or mastics from panel edges.
11. Apply a new bead of sealant and reinstall front and rear vertical edge trims covering panel edges.
12. Reinstall belt and sash moldings using the applicable “Installation” procedures in Section 3C of this manual.

Service Doors

1. Remove any rivets securing panel to door frame.
2. Pry out on interior overlap flanges and remove the panel from the door frame.

NOTE: The rear service door panels are retained with a very strong two-sided tape.

3. Apply new tape to the vertical frame members only to install new panel.
4. Carefully slide new panel onto service door frame, pushing out from interior to keep it away from tape until positioned.
5. When positioned properly, apply pressure to bond new panel to the tape and let stand overnight.

Baggage Doors

1. Drill out edge flange rivets and remove the panel from the door frame.

NOTE: The baggage door panels are held with edge rivets, tape and mastics.

2. Apply new tape to the frame members along with a new bead of mastic to reinstall new panel.
3. Install new panel onto baggage door frame, and apply pressure to bond new panel to the tape and mastic.
4. Drill and install new rivets adjacent to old rivets. Wipe any excess mastics from panel interior, and let stand overnight.

NOTE: Large panels may require additional clamping to assure complete adhesion.

SPECIFICATIONS

FILLER METALS

APPLICATION	DIAM.	A.W.S
SS to SS or Cor-Ten, Light Gauge	3/32 Inch (2.4 mm)	No. 308
SS to SS or Cor-Ten, Heavy Gauge	1/8 - 5/32 Inch (3.2-4.0 mm)	No. 308
Corten to Cor-Ten, Light Gauge	3/32 - 1/8 Inch (2.4-3.2 mm)	No. 6011
Corten to Cor-Ten, Heavy Gauge	3/32 - 5/32 Inch (2.4-4.0 mm)	No. 7018
Air Beam Reservoirs, Heavy Plate Sections	5/32 Inch (4.0 mm)	No. 7018

SECTION 3B

INTERIOR COMPONENTS

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Driver's	3B-7
Midi-galley	3B-8
Destination Sign	3B-9
Removable Destination Sign Curtain and Roller Replacement	3B-9
Maintenance	3B-9
Sign Curtain Repair	3B-9
Sign Installation	3B-12
Service Tools	3B-14

GENERAL DESCRIPTION

The driver's floor, front entrance area and front aisle are all at the same level. The floor is $\frac{1}{2}$-inch (13 mm) thick 5-ply waterproof fir plywood. The floor is securely attached to the under frame with elevator bolts and self-tapping, countersunk screws and all joints are sealed with mastic. The underside of the floor is treated with fire retardant paint and the top is sanded and covered with a heavy duty, quality rubber. The following are used: $\frac{5}{16}$-inch (8 mm) ribbed, metal backed stepwell tread plates; $\frac{3}{16}$-inch (5 mm) ribbed entrance area and ramped aisle area (no metal back); $\frac{1}{8}$-inch (3 mm) smooth driver's area; $\frac{1}{8}$-inch (3 mm) smooth center aisle; $\frac{1}{8}$-inch (3 mm) smooth under seats.

The seats are securely fastened with high tensile tee-bolts in a high strength aluminum alloy track, (bolted) on the wall and a stainless steel track (welded) to the floor frame. Floor tracks are flush to the top of the floor covering.

Overhead luggage racks are provided on both sides of the coach above passenger seats and driver's area. An extruded aluminum frame spans the length with polycarbonate structural foam support ribs at points in between. The floor of the rack is aluminum which is covered with vinyl or carpet. Other exposed surfaces are thermo-formed ABS plastic.

Luggage retention cords are included as basic (two each side) or, as optional equipment, enclosing doors are installed at each module. The doors are top-hinged and held in the open position by gas cylinders. A latch at bottom center of each door engages to form a positive lock in the closed position.

A passenger service module is mounted on the underside of the racks above each passenger seat location. Housed in the modules are passenger reading lights with switches, call switch, speakers and optional individually controlled air outlets.

Fluorescent lighting is provided at window side and aisle side of the racks, illuminating interior of luggage racks as well as passenger areas of coach. Optional 110-volt in-station lights are available at aisle side of racks only or at aisle and window side combined. The fixtures are 24-volt, fed from coach power or from a 110-volt converter when equipped with the option(s).

Surfaces may be cleaned with a mild detergent and water. Avoid the use of cleaners containing abrasives.

The ceiling at the extreme front and the rear window area is fiberglass reinforced plastic, gelcoated surfaces are color impregnated with the appropriate color, molded panels while the main ceiling area is vinyl clad aluminum. Vinyl and aluminum moldings cover panel joints. Lower side wall trim below windows is melamine paneling.

MAINTENANCE

ROUTINE CLEANING

Upholstery

In both appearance and wearability, best results are obtained if upholstery is cleaned at regular intervals before dirt, dust and grit have been ground into the fabric.

All that is required to remove the dirt is a gentle beating with the hand or the back of a brush. This will bring the dirt to the surface where it is easily removed by a vacuum or a soft brush. It is preferable to vacuum or brush in the direction of the pile which can easily be recognized by running a hand lightly over the pile. Cleaning should be carried out as often as possible. If the fabric becomes excessively dirty, particles of grit will cause gradual wear to take place, reducing the life of the fabric.

DRY CLEANING

If covers are to be removed for cleaning, dry cleaning is recommended since washing might cause some shrinkage, preventing the covers from being reapplied to the seats without damage. Stoddard Solvent is recommended as the dry cleaning agent because most covers used on seats are a combination of cloth and vinyl, and this product assures longer vinyl life. Other than spot cleaning, dry cleaning the covers while they are in place is not recommended; the resulting fumes could be hazardous in the confines of the coach and the solvent could be detrimental to the foam padding of the seats.

Cleaning With Covers In Place

The most effective and economical method to clean the woven fabric seat covers is by washing with either an approved foam upholstery cleaner or with a mild household detergent such as *Joy, All* or *Tide.*

Follow this procedure when cleaning seat backs and cushions:

1. Thoroughly vacuum the upholstery and if spots or stains are to be removed, do so before the seats are washed in order to avoid a “cleaning ring.”

2. Dilute household detergent or liquid foam cleaner according to directions on the container, pour a small quantity into a flat pan and work into a thick foam with a sponge or brush.

3. Apply only the foam to the fabric using a brush, sponge or Turkish towel. Clean only a small area of the fabric at a time with the foam. AVOID SOAKING! Rub vigorously. If the fabric is mohair, brush the dampened surface in the direction of the pile several times with a stiff brush. When dry, brush against the pile to restore the nap.

4. Follow the scrubbing by sponging the suds from the fabric with a clean sponge or a clean cloth moistened with water. Rinse the sponge or cloth often, and change the water when it becomes dirty and/or “sudsy.”

5. Before the coach goes back into service, the upholstery should be allowed to dry. To speed up the drying, excess moisture can be blown off the fabric with compressed air.

> **NOTE:** Oil in the air line will soil the fabric. Blow the line clear and test air discharge against a plain white piece of paper. It is also effective to press the edge of a flat stick of hardwood down on the cushion and slowly draw it across the fabric.

Even very soiled areas can be returned to their original appearance by a thorough cleaning. But a regular schedule of cleaning that keeps your upholstery reasonably clean at all times will add months to the service life of coach upholstery.

Recommended Cleaning Schedule

After the vehicle comes off its regular run, seats should be brushed after the floor of the bus has been swept. A whisk broom is generally used.

> **NOTE:** Maintenance personnel often use sweeping compound to inhibit dust.

Once a week at minimum, the seat cushions and seat backs should be vacuum cleaned. Then the seats should be wiped with a damp, clean cloth to remove any dust or dirt raised to the surface of the fabric but not removed by the vacuum.

Vigor Moquette is a wool plush fabric manufactured as a heavy duty upholstery fabric for the Bus and Coach industry. For Vigor Moquette, beat the pile with a brush and vacuum off the dust, dirt and grit. Clean as often as possible as the construction of the cloth allows dust, dirt and grit to fall to the base of the pile, presenting clean pile to the user. The grit will cause excessive abrasion to the pile which will reduce the the life of Vigor Moquette.

At each mechanical check-up during which the vehicle remains in the shop for 24 hours or more, the seat upholstery should be vacuum cleaned, spots removed and then “shampooed.”

REMOVAL OF STAINS

Fabric Type Upholstery

WARNING

Do not use soap, washing powder, ammonia, soda, bleach or any product that contains them. Serious damage could occur to either the dye-stuffs or the wool in the pile of the fabric.

NOTE: Prompt and proper cleaning will remove most stains. Improper treatment may increase the damage. In cases where there is doubt, always seek expert advice. This information is, to the best of our knowledge, true and accurate, but all recommendations or suggestions are made without guarantee since the conditions of use are beyond our control.

The two general methods of cleaning fabrics and wool plush fabrics are:

Method 1

Apply a nonflammable solvent (Trichloroethylene) with a clean, white, absorbent material. Treat small areas, working from the outer edge toward the center of the stain. Blot frequently with a dry clean cloth to avoid rings. OPEN WINDOWS AND DOORS TO ALLOW FUMES TO DISPERSE.

Method 2

Sponge the stain with a solution of household detergent and lukewarm water. DO NOT SOAK. Follow this by rubbing with a damp cloth, rinsing the cloth between each treatment.

ALCOHOLIC LIQUIDS - Sponge with water followed by Method 2, below.

BATTERY ACID - Saturate with a solution of Sodium Bicarbonate, leave a few minutes before drying out. It is important for the above treatment to be carried out immediately to avoid serious damage to the fabric.

BEVERAGE STAINS - Use Method 1, if stain persists, try Methylated spirits.

BLOODSTAINS - Use Method 2.

BURNS - Scrape blackened area with a knife and treat with Method 2, below. Restoration after extensive burns requires attention from a tailor or seamstress.

CHEWING GUM - Soften with Cyclohexanone and scrape off carefully with a knife.

COSMETICS - Use Method 1, followed by Method 2.

BALLPEN INK - Treat with Methylated spirits, blotting frequently to avoid ink spreading. Use cleaning Method 2 to complete the removal.

COPYING INK - Treat same as ballpen ink.

MARKING INK (from felt-tipped pens) - Treat with Methyl Ethyl Ketone (MEK) followed by Method 2.

WRITING INK - Use Method 2, below. If brown stain remains, treat as for rust.

OIL, GREASE OR PAINT MARKS - Remove excess substance with a knife or spoon, then treat with Method 1, followed by Method 2. If stains reappear, repeat the cleaning process.

RUST - Use Method 2, followed by a warm solution of Oxalic Acid and complete treatment by sponging with water.

TAR - Soften with Benzene and then treat with Method 1, followed by Method 2.

URINE - Use Method 2.

VOMIT AND EXCREMENT - Use Method 2.

Vinyl Covers and Trim

The vinyl on the seats requires periodic cleaning to retain a neat appearance.

Use only mild household detergents such as No. 409 Cleaner with warm water and apply with a sponge or soft cloth to remove most soiling. In addition, a soft-bristle brush may be used after the detergent has been applied to the surface.

CAUTION

Do not use harsh solvent type cleaners such as Lestoil or Fantastic. Such solvent cleaners cause cracking, crazing and general deterioration of the vinyl and thread materials.

In case of stubborn or embedded dirt, a non-abrasive cleaner such as Bon Ami can be effective. Before the surface dries, wipe with a clean, dry cloth to remove residue. This procedure may have to be repeated to remove some stains and dirt.

REMOVAL OF SPOTS AND STAINS

Vinyl Covers/Trim

The following suggestions are often effective in removing the types of stains and spots listed.

- Ink can sometimes be removed by use of alcohol.
- Paint, shoe polish and tar can best be removed by using naphtha or kerosene on a clean white cloth.
- Chewing gum may be removed by first carefully scraping the surface and then using naphtha or kerosene on the remainder.

Do not use any stronger solvents as they will attack vinyl and plastic compositions. After using solvents, wash the vinyl surface with detergent solution and rinse with clean water. Dry with soft, clean cloth.

Badly stained vinyl surfaces can be rejuvenated with Color Hit, a flexible color coating made by Advance Color Corporation, 800 South Vail Avenue, P.O. Box 54870, Los Angeles, California 90054. This product is an opaque, water-base coating available in 25 standard colors.

Cleaning Fabric On Windshield Posts And Beams

The polylycra fabric on windshield posts and on the beams above the windshield can be cleaned with warm water and a mild detergent. After cleaning, use a clean, dry absorbent cloth to pat off the excess moisture. The 35 micron film to which the fabric is bonded will prevent moisture from penetrating the post cover materials. A dry sprayable powder (such as K2R) can be used to clean stubborn stains without affecting the overall appearance of the fabric.

⚠ CAUTION ⚠

Do not use solvent based liquids to clean the fabric; the fabric and the underlying materials may be adversely affected.

ROUTINE CLEANING

Carpeting

A regular maintenance plan will help you maintain the beautiful appearance of your carpeting for many years. To maintain the best appearance level possible, follow the basic maintenance plan below.

⚠ CAUTION ⚠

Do not use soap, washing powder, ammonia, soda or bleach. Prompt cleaning will remove most stains. Improper treatment may increase the damage.

Light vacuuming or carpet sweeping is usually needed daily in heavy traffic areas. This is to pick up most surface dust, lint and soil. Carpet sweeper or cannister type vacuums work well for quick cleaning.

A vacuum equipped with a beater bar or a very high air velocity commercial vacuum is needed for thorough vacuuming. The beater agitates the pile to free abrasive dirt particles buried below the surface. Move the vacuum slowly to give the dirt time to be shaken loose and drawn up by the vacuum.

Commercial cleaning of the carpet is recommended each year, depending on conditions, for those who want the best appearance and longest life from their carpet.

STAIN REMOVAL

The following materials can be readily obtained for use in a spot removal kit. Bottle and label them for future use.

Dry cleaning fluid (nonflammable such as Perchlorethylene).

Detergent solution mix one teaspoon (5 ml) of neutral powder type of detergent in $1/2$ pint (280 ml) of water.

Solution to neutralize acid stains (fruit juices). Mix one tablespoon (15 ml) ammonia to $3/4$ cup (177 ml) of water.

Solution to neutralize alkaline stains (bleach, wine, urine). Mix $1/3$ cup (79 ml) of white vinegar with $2/3$ cup (157 ml) of water.

Clean, white absorbent cloths, a sponge, an eyedropper.

ALCOHOL - Detergent solution.

BALLPOINT INK - Dry cleaning fluid.

BEER - Detergent solution followed by small amount of vinegar.

BLOOD - Detergent solution followed by ammonia solution, then vinegar solution and a dry cleaning fluid after spot is dry.

BUTTER - Dry cleaning fluid.

CANDY - See section on “Difficult Stains.”

CARBON BLACK - Detergent solution.

CHOCOLATE - Apply dry cleaning fluid followed by detergent solution.

COFFEE - Detergent solution.

COSMETICS - Dry cleaning fluid (except lipstick).

CRAYON - Dry cleaning fluid.

CREPE PAPER - Detergent solution.

EGG - Treat as for chocolate.

EXCREMENT - Remove all solids, then treat as for beer.

FOOD COLOR - Detergent solution.

FOOD STAINS - Remove all solids, then treat as for chocolate.

FRUIT JUICE - Detergent solution followed by ammonia solution.

GELATIN - Detergent solution.

GLUE - Detergent solution.

GRASS - Treat as for chocolate.

GRAVY - Treat as for chocolate.

GREASE - Dry cleaning fluid.

GUM - See section on “Difficult Stains.”

HOUSE CEMENT - Dry cleaning fluid.

ICE CREAM - Detergent solution.

IODINE - Detergent solution.

KETCHUP - Detergent solution.

METAL POLISH - Dry cleaning fluid.

MILK - Treat as for chocolate.

MUSTARD - Detergent solution.

NAIL POLISH - See “Difficult Stains.”

OILS - Dry cleaning fluid.

PERMANENT INK - Detergent solution.

RUST - See “Difficult Stains.”

SHOE POLISH - Dry cleaning fluid.

SOFT DRINKS - Detergent solution.

SOOT - Detergent solution.

TAR - Dry cleaning fluid.

TEA - Detergent solution.

TOOTHPASTE - Detergent solution.

URINE - See “Difficult Stains.”

VASELINE - Dry cleaning fluid.

VOMIT - Remove all solids, then treat with detergent solution.

WATER COLORS - Detergent solution followed by ammonia solution.

WAX - Dry cleaning fluid.

WINE - Detergent solution followed by vinegar solution.

DIFFICULT STAINS

CANDY - Use the stain removal method for chocolate but apply the vinegar solution and then water once the stain is removed.

GUM - Easily removed by quick freezing it with dry ice and hitting it sharply with a hammer or hard instrument. Then scrape it off and remove any residue with dry cleaning solvent or soften with cyclohexanone and scrape off carefully with a knife.

NAIL POLISH - Can be satisfactorily removed with nail polish remover, but it can seriously damage any carpet containing acetate fibers. Test it first sparingly in some inconspicuous area of the carpet and, should the color run, contact a professional cleaner for assistance.

STRONG ACIDS - Such as carbolic acid disinfectant and some tile cleaning compounds require drastic and immediate action to prevent serious damage. Quickly flush the affected area with water. Sponge up excess water, and repeat several times to dilute acid and wash it away. Sponge the area with ammonia solution and rinse again. Be sure to dry the carpet as quickly and thoroughly as possible, using a fan or vacuum cleaner.

STRONG ALKALIES - Such as lye, caustic soda, oven cleaner and paint cleaner can cause serious damage. Immediate attention is essential. Quickly flush the affected area with water as described under “Strong Acids,” then sponge area with vinegar solution and rinse again. Dry the carpet as in “Strong Acids.”

URINE - Absorb all liquid with a tissue or paper towel. Work (do not rub) a neutral detergent into stain and repeat. Apply one part white vinegar to two parts water and work (do not rub) into yarns. Allow it to set and then absorb excess liquid. Place absorbent material on top and weigh it down (books, etc.) and leave for 6-8 hours to dry.

UNKNOWN STAINS - If they are “set” or are not identifiable, try detergent and water first. If this does not work, let stain dry and then try dry cleaning fluid. If this does not remove the stain, contact a professional carpet cleaner for assistance.

Driver’s and Passenger’s Modesty Panels

The modesty panels are made of fiberglass with a smooth, easily cleaned gel-coat finish.

Cleaning with mild detergent and water will remove most surface soiling. Tar, gum, etc., may be removed with a solvent such as kerosene. Volatile solvents, such as acetone, are not recommended. After using a solvent, clean the area with mild detergent and water.

Driver’s Acrylic Guard Panel

An acrylic panel is mounted above the driver’s modesty panel. Care should be taken when cleaning it.

The panel should first be dusted very lightly (not wiped) with a soft, clean cloth. The surface can then be wiped carefully with a soft, wet cloth or chamois. The cloth or chamois should be kept free of grit by rinsing it often in clean water. A mild dishwashing detergent may be used if necessary.

Grease and oil may be removed with hexane, kerosene, or aliphatic naphtha (no aromatic content).

⚠ **CAUTION** ⚠

Do not use solvents such as acetone, benzene, carbon tetrachloride, fire extinguisher fluid, dry cleaning fluid, or lacquer thinners, since they soften and distort acrylic material. Do not use window sprays or kitchen scouring compounds.

If, after washing, the surface shows minor scratches, most of them can be removed or reduced by hand polishing. The polishes can be best applied with a small pad of soft cotton flannel which has been dampened with water. Rub the panel in a straight to-and-fro motion parallel with the light scratches to be removed, or with a circular motion. Excessive rubbing at one spot should be avoided. Several applications may be necessary, but most minor scratches can be reduced and clarity improved within a relatively short time.

After the scratches are removed or reduced, the cleaner should be removed with a clean, soft cloth.

VINYL REPAIR

Remove existing damaged vinyl covering from metal panel. Thoroughly clean the panel. Use a toluene cleaning fluid. Apply a coat of No. 1368 3M contact cement to panel and bottom side of vinyl. Allow cement to dry until tack-free before applying vinyl to panel.

NOTE: Cement must be sprayed on smoothly. If spraying equipment is not available, the cement can be brushed on; however, application must be thin, uniform and smooth.

1. Apply masking tape around the outside area of the precise area to be covered by the patch. Using medium grit (120) sandpaper on a sanding block, thoroughly abrade the entire area that is to be covered. Wipe all residue off the surface with a tack-rag or with a clean cloth dampened with isopropyl alcohol. Spray or brush a thin, uniform DI-NOC brand primer 8004 on the surface and allow to dry for approximately 15 minutes. Remove all masking tape before the primer dries.

2. Cut the patch of 3M vinyl to the precise size of the area to be covered. Oversized patches will not adequately adhere to the unprimed edges and undersized pieces will leave non-coated areas of film which would be susceptible to staining and discoloration.

3. To remove the liner, place the vinyl face down on a clean, flat surface, hold firmly and remove the liner or backing with a smooth 180 degree motion. During hot or humid weather a slight jerking motion will aid in the liner or backing removal.

NOTE: Always remove the liner or backing from the vinyl; never the vinyl from the liner or backing as vinyl stretching may result.

4. Cut the liner or backing into two pieces (about 1/3 and 2/3 of its original size). Do not cut the vinyl (Figure 1). Place patch face down on a flat surface. Peel back and cut off approximately 1/3 from one edge.

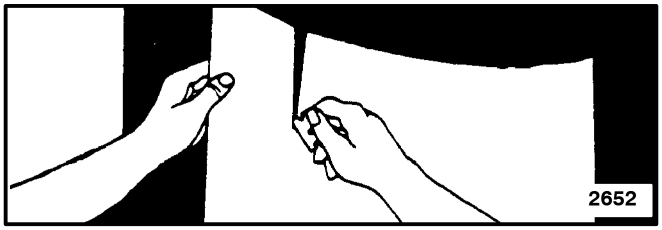


Figure 1. Cutting Liner or Backing

5. Replace the two liner or backing pieces on the vinyl (adhesive side), leaving a gap of one to two inches between the two pieces (Figure 2). Replace liner paper on adhesive, plastic side down, exposing about 1-2 inch (25.4-50.8 mm) of adhesive.

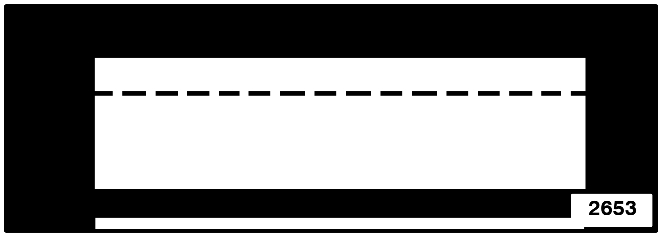


Figure 2. Replacing Lining Paper

6. Use plastic applicator to burnish the exposed section of the vinyl. Use firm, overlapping strokes working from the center to the edge. This section will now act as a hinge when applying the rest of the vinyl. Apply marking along line of exposed adhesive.

7. Lift the smaller (1/3) section of the vinyl and remove the liner or backing as you “squeegee” with firm, overlapping strokes. Repeat with larger (2/3) section. Go over all edges to ensure that they are firmly adhered (Figure 3).

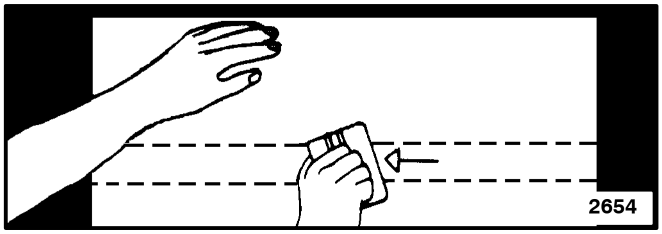


Figure 3. Burnishing Vinyl

CLEAN-UP

Use a clean cloth dampened with either MEK (Methyl Ethyl Ketone) or lacquer thinner to clean up any residual adhesive which may have oozed out from beneath the vinyl.

⚠ WARNING ⚠

Di-noc brand primer 8004, mek (methyl ethyl ketone) and lacquer thinner are flammable liquids. Use only in well ventilated areas away from flames or sparks. do not soak the vinyl with these materials.

ALTERNATE METHOD OF VINYL REPAIR

A vinyl repair product is available from Advance Color Corporation, 800 South Vail Avenue, P.O. Box 54870, Los Angeles, California 90054. This product, called Instant Vinyl, is used for repairing cuts, tears, cigarette burn holes and the like in any vinyl upholstery material. Instant Vinyl is a clear, jelly-like substance which acts as a bond between the edges of the original vinyl and, in effect, replaces vinyl, providing a smooth and completely flexible seam or weld.

FLOOR COVERING REPLACEMENT

1. Remove existing damaged floor covering from wood floor. Thoroughly clean the floor by wire brushing or sanding.
2. Remove all sanding dust and other foreign matter. Floor must be clean before applying adhesive.
3. Under passenger seats, on center aisle, driver's area and entrance area, apply a coat of Armstrong Lino Cement No. SP235 (MCI Part No. 19-16-353) adhesive to plywood floor. Vinyl covering can be applied immediately.

SEATS

PASSENGER

Coach seats are lightweight, with foam-padded backs and cushions. Arm rests are provided at both the wall and aisle sides of passenger seats. Outside back panels are scuff resistant plastic. Removable upholstery covers are standard with vinyl side boxing at headrest areas and woven fabric facings on cushions and backs.

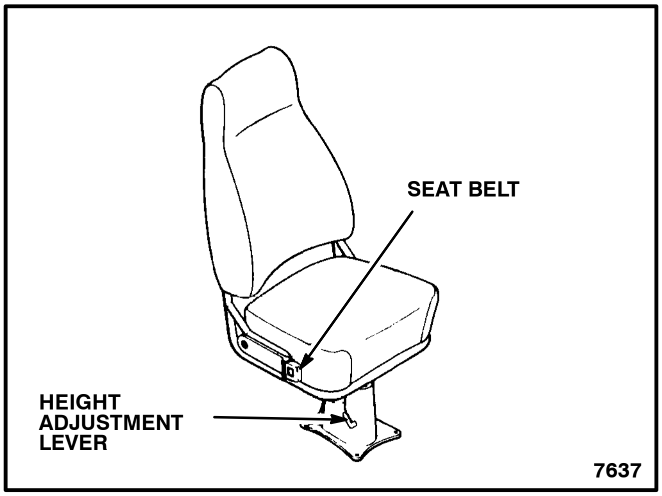


Figure 4. Driver's Seat

DRIVER'S

The driver's seat may be adjusted fore and aft by pushing in the lock lever located at left front of seat (Figures 4 and 5). When seat is positioned, release the lever. The back of the seat cushion can be tilted up or down by grasping the large knob at left corner of driver's seat and turning forward to lower and backward to raise. Seat may be raised by grasping and firmly pulling seat frame up. To lower, raise seat to highest position, then lower seat to lowest position. From there raise seat to desired height.

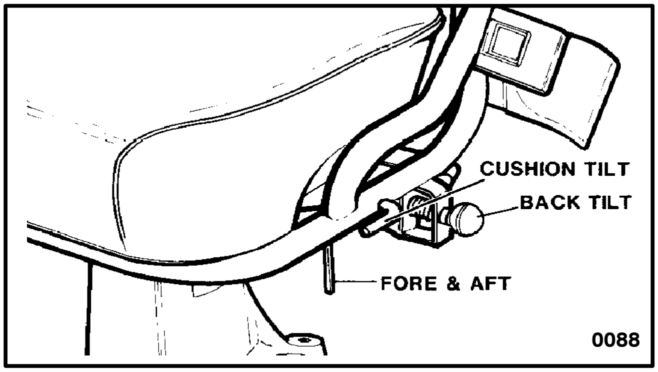


Figure 5. Driver's Seat Adjustments

SEAT BELT

⚠ WARNING ⚠

Seat belt is to be used at all times when the coach is in motion.

The seat belt is self-adjusting and equipped with a recoil lock mechanism. In case the reel operation becomes "sluggish" lightly spray it with aerosol lubricant while holding the belt fully extended.

MAINTENANCE

The seat belt mounting must be inspected for looseness at least twice a year. If it becomes necessary to clean the webbing, use a mild detergent with lukewarm water. Do not re-dye or use solvent type cleaners on webbing. This may weaken the fibers or affect the original dye. When fraying takes place, replace belt.

MIDI-GALLEY

The midi-galley is located in the rear cross seat area (Figures 6 and 7).

The cabinet is made of ¾-inch plywood with a melamine exterior. A stainless steel splashguard is installed along the back and along the window side of the cabinet top. A stainless steel spillguard extends across the front of the cabinet top.

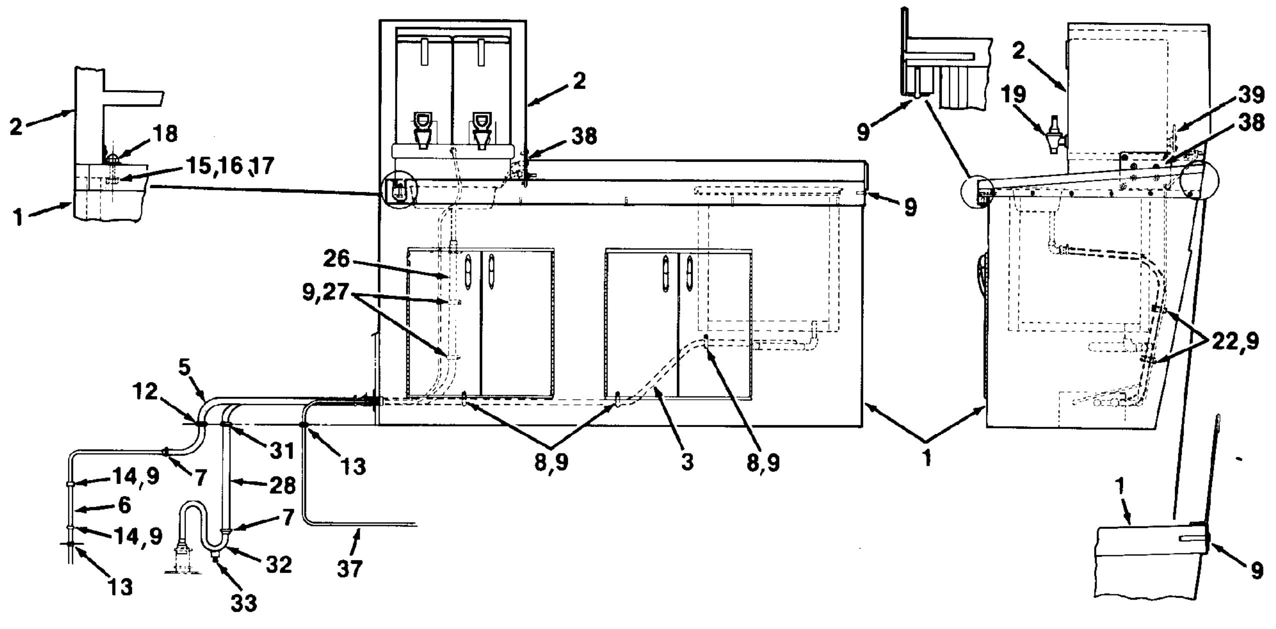
A stainless steel, double-walled ice chest is recessed into the cabinet top at the window end. The chest has styrofoam insulation sandwiched between the walls. The chest lid is constructed similarly and is hinged in the center for access to either side of the chest. The chest lid can be lifted off if desired. A manually operated valve located under the chest allows the chest to be drained through a drain hose. Drain water goes onto the ground.

Optional bottle holders are installed at the rear center of the cabinet top.

Two optional beverage containers are housed in a melamine-covered cabinet which is adjacent to the lavatory wall and which is anchored to the cabinet top. A drip tray is recessed into the cabinet top just in front of the liquid container spigots. A hose from the tray to the lavatory retention tank drains the tray. The beverage containers are stainless steel, insulated and hermetically sealed. Each container has a two-gallon capacity.

As an option, the beverage containers can be heated. Provisions for allowing heating consist of two 24-volt electrical outlets into which the dispenser is plugged, a switch panel with switches and indicator lights, and the associated wiring. The heating units permit the temperature of liquids to be held at approximately 185°F.

The beverage containers may also be used for chilling liquids. Dry ice is placed in the container's ice well which extends from the dispenser lid downward into the container. The heating elements must be turned "Off" when the dry ice wells are used.



1. Lower Cabinet
2. Upper Cabinet
3. Hose Assembly
4. Junction Plate Assy.
5. 3/8" I.D. Hose
6. Tube-Ice Chest Drain
7. Hose Clamp
8. Line Support Clamp
9. Tapping Screw-#8 x 3/4"
10. Connector
11. Connector Tube
12. Grommet
13. Grommet
14. Line Support Clamp
15. Capscrew-5/16-18 UNC x 1 1/4"
16. Lockwasher-5/16"
17. Lockwasher-5/16"
18. Acorn Nut-5/16-18 UNC
19. Liquid Dispenser
20. Drip Tray
21. Ice Chest
22. Spill Guard
23. Rear Splash Guard
24. Side Splash Guard
25. Flathead Screw-#10 x 2"
26. Hose Assembly
27. Line Support Clamp
28. 1/2" I.D. Hose
29. Short Elbow Tube
30. Connector
31. Grommet
32. Water Trap S/A
33. 1/4" NPT Water Valve
34. 3/8" NPT Pipe Plug
35. 1/2" I.D. Hose
36. Tube and Casting S/A
37. Harness
38. Switch Plate Assy.
39. Liquid Dispenser Heating Receptacle

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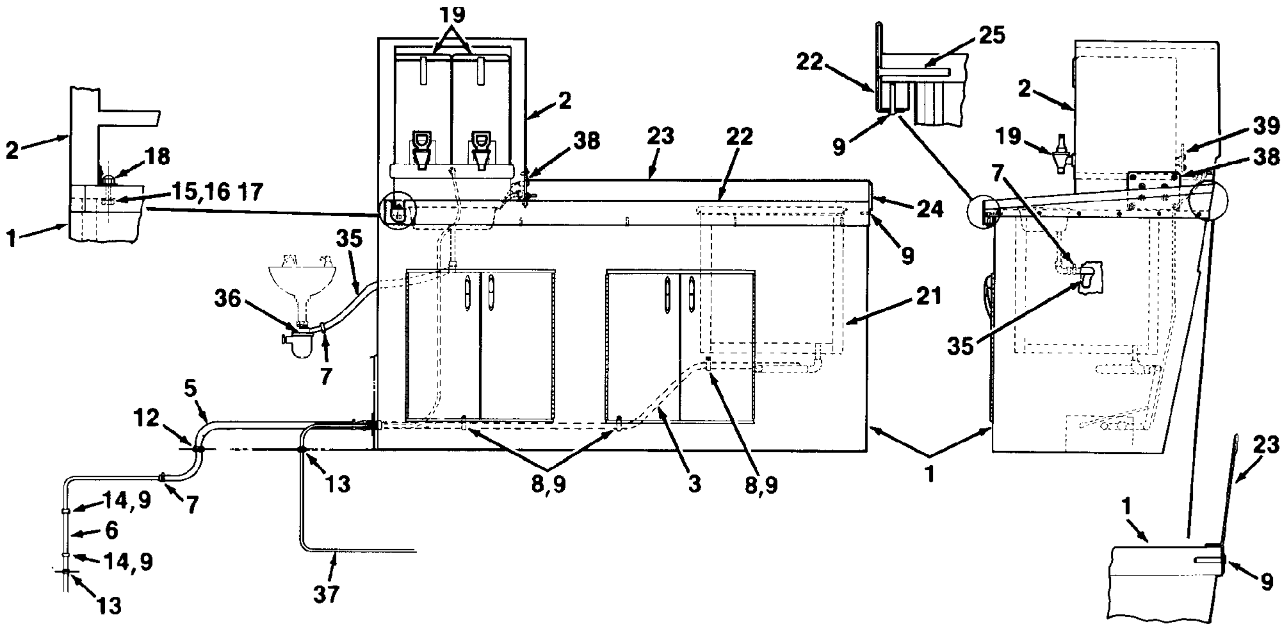
Figure 6. Midi-Galley Installation (Lavatory Without Wash Basin)



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32. Water Trap S/A
33. 1/4" NPT Water Valve
34. 3/8" NPT Pipe Plug
35. 1/2" I.D. Hose
36. Tube and Casting S/A
37. Harness
38. Switch Plate Assy.
39. Liquid Dispenser Heating Receptacle

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Figure 7. Midi-Galley Installation (Lavatory With Wash Basin)

DESTINATION SIGN

REMOVABLE DESTINATION SIGN CURTAIN AND ROLLER REPLACEMENT

The removeable destination sign is located in the window above the windshield. The construction of the upper and lower idler rollers in the removable destination sign is nylon. This provides a smooth operation with no noise production while the coach is in motion. It is gear driven by an electric motor and activated by a rocker switch on the back of the sign above the driver (Figure 8).

MAINTENANCE

Regularly inspect for the following:

1. Check for free movement of mechanism.
2. Check for loose items, i.e., wires, clips, hanging tape. Repair or remove as necessary.
3. Inspect inside of sign compartment. Remove dirt and foreign objects. Clean inside of compartment well and keep door closed.

NOTE: Destination sign mechanism has nylon gears; no lubrication is required.

SIGN CURTAIN REPAIR

In the event a destination sign curtain is torn, it can be repaired with 3M polyester tape or any equivalent cellophane tape. When repairing a tear, the tape should be used on both sides of the curtain.

When it becomes necessary to install or add curtain inserts, butt splice or overlap and apply strip of 3/4-inch (19.0 mm) wide polyester tape over front and rear seam.

The above method is an easier and more accurate way of installing inserts than the sewn methods. It also makes for considerably less bulk and better turning of curtain rolls.

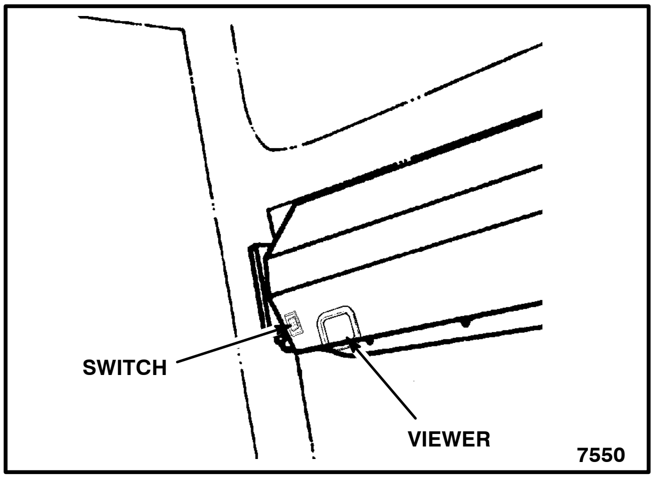

SWITCH
VIEWER
7550

Figure 8. Fixed Destination Sign Components

REMOVAL

1. Unplug the sign harness from the socket on the left-hand windshield post (Figure 9).

2. Turn the Dzus fastener on the right-hand side of the sign box to release the box from the bracket on the center windshield post.

3. Lift the right-hand end of the sign assembly upward and outward to free the hooks on the right-hand end of the box from the bracket on the center windshield post.

4. Pull the box to the right to free the pins on the left-hand end of the box from the bracket on the left-hand windshield post.

5. Place the sign assembly face down on a firm padded surface to avoid scratching or damaging the sign window.

DISASSEMBLY

1. Remove and save the four screws on the sides of the back cover of the sign and lift off the cover.

2. Remove and save the fluorescent light tube from the sign. Refer to Figure 10 for parts and locations referred to in the following steps.

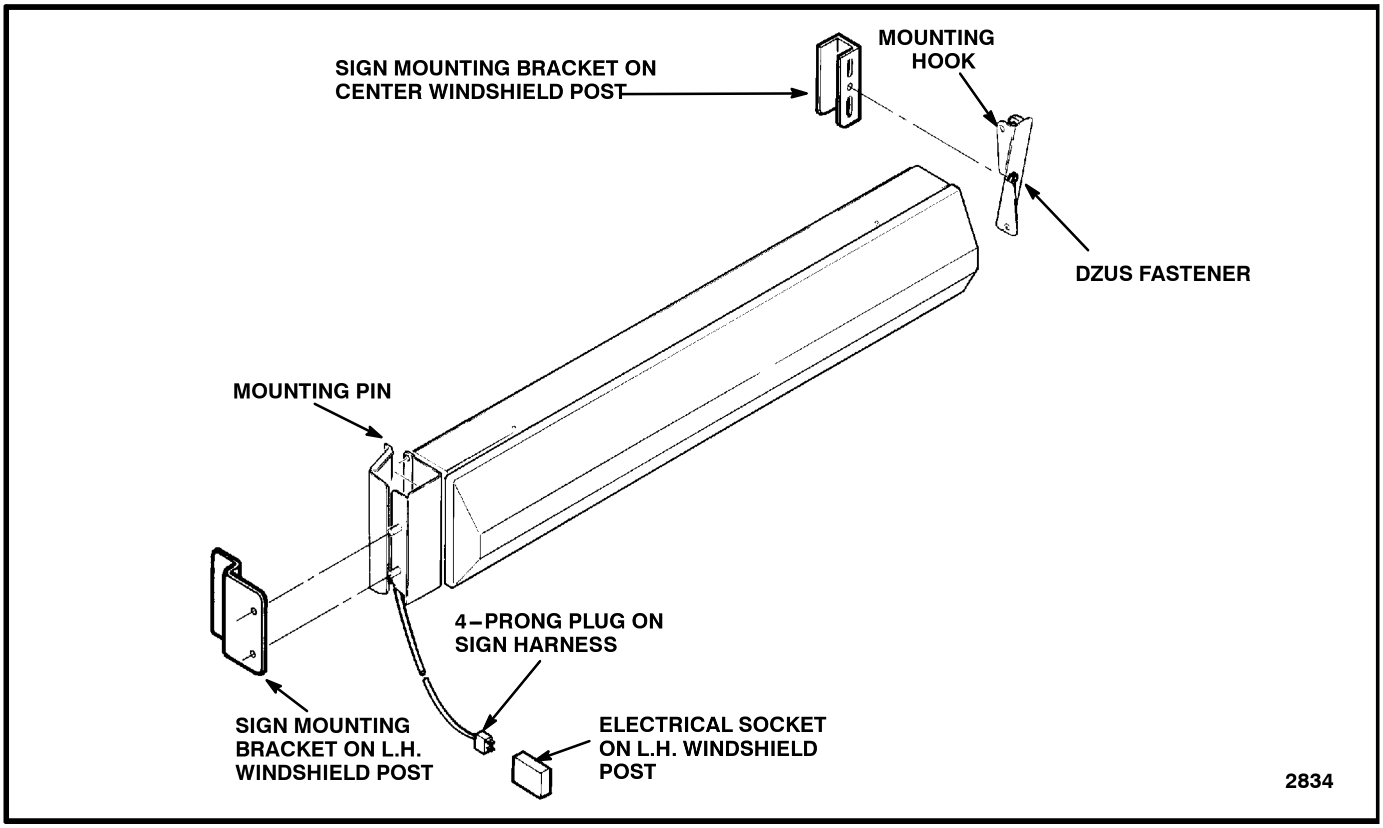

SIGN MOUNTING BRACKET ON CENTER WINDSHIELD POST
MOUNTING HOOK
DZUS FASTENER
MOUNTING PIN
4-PRONG PLUG ON SIGN HARNESS
SIGN MOUNTING BRACKET ON L.H. WINDSHIELD POST
ELECTRICAL SOCKET ON L.H. WINDSHIELD POST
2834

Figure 9. Removable Destination Sign Installation

3. Manually unwind either curtain roller until a few inches of slack are obtained in the curtain. This allows the other curtain roller to be removed by popping the end of the roller out of the roller retaining slot.

4. Lift the end of the roller and the curtain clear of obstructions in the sign box, and then, **taking care not to crease or tear the curtain, pull the other end of the roller free from the spindle.**

5. Lift the freed roller clear of the sign box, unrolling additional curtain as the roller is lifted. Continue unrolling until the roller can be laid on the work surface on which the sign box is resting.

6. Wind the remaining curtain on the freed roller onto the roller that is still in the sign box. Continue rewinding until the end of the curtain and the groove in which it is fastened is exposed.

7. Pull one of the flanged ends off the end of the roller so that the end of the strip holding the curtain in the roller groove is accessible.

8. Remove the tape securing the curtain ends to the ends of the roller.

9. Hold the roller steady and grasp both edges of the curtain just above the roller groove and carefully pull the curtain and retaining strip out of the roller groove (see Figure 11). When the curtain and retaining strip are freed from the roller, remove the strip and save it for reinstallation.

10. Roll all of the curtain that was on the freed roller and all that is in the sign box onto the roller that is still in the sign housing.

11. Remove the roller and curtain from the sign housing using the roller removal procedure above.

Note: Make a note or mark from which roller retaining slot and spindle the roller and curtain are removed so they can be reinstalled in the proper position in the sign box.

Continue If Replacing Idler Roller Tubes

12. Remove and save the capnuts from the ends of the threaded rods passing through each of the idler rollers. Loosen the jamnuts (inside the sign housing) on the threaded rod.

13. Turn the left end of each threaded rod until the jamnut on the right end can be removed, then turn the rod in the opposite direction until the left jamnut can be removed. Retain the jamnuts.

14. Slide the rod out of the idler roller tube and out of one end of the housing. Retain the threaded rod for re-use.

15. Remove and discard the idler roller tubes.

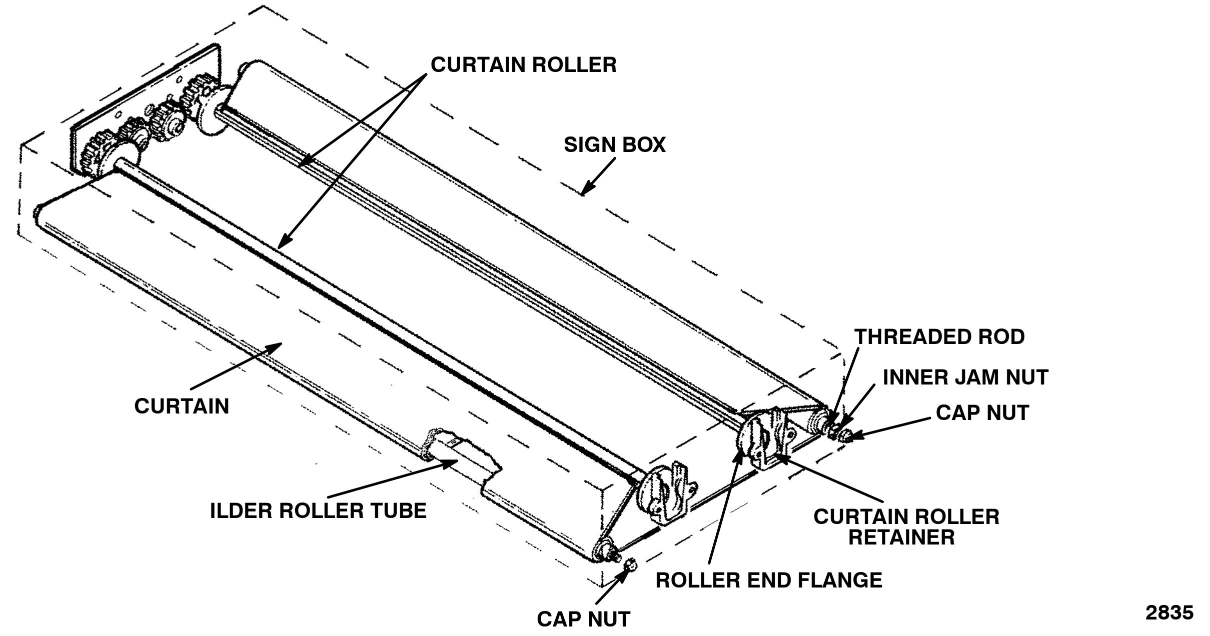


Figure 10. Sign Box Rollers and Curtain

REASSEMBLY

1. If replacing idler roller tubes. Position one of the new tubes in the sign housing. Slide one of threaded rods through the hole in either end of the housing and all the way through the idler roller tube.

2. Place one of the jamnuts on the inside of the housing and screw the rod into it and out through the hole in the end of the housing. Continue turning the rod until enough of it has passed through the housing to allow putting a jamnut on the inside of the other end. Reverse direction of the rod's rotation and screw it back through the jamnuts until equal lengths of rod are protruding from each end of the box.

3. Tighten the jamnuts and put the cap nuts on the outside ends of the rod. Repeat the process to install the other idler roller and threaded rod.

4. Replace curtain on curtain roller (if new curtain is being installed).

5. Reinstall the curtain roller with the curtain on it. Install the roller in the same slot from which it was removed.

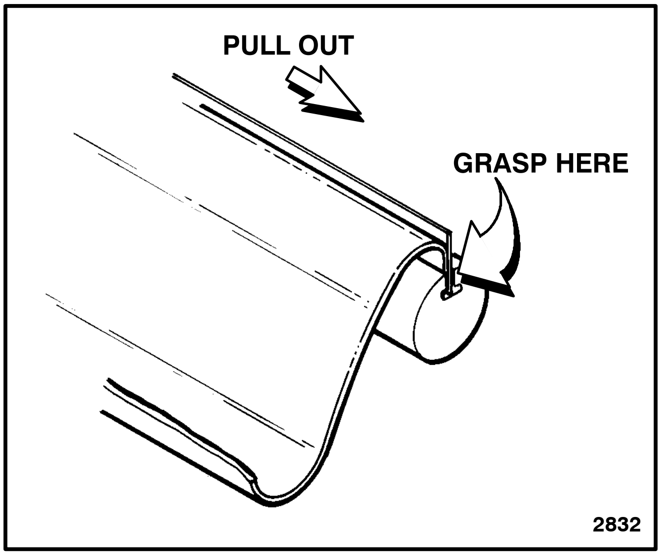


Figure 11. Removal of Curtain From Roller

Begin pulling out the curtain and feed it over, behind and under the nearest idler roller. Continue pulling the curtain until it passes across the window and reaches the other idler roller. Feed the curtain under, behind and over that roller and then pull out an additional length of curtain so that the free end can be fastened to the other curtain roller which is still outside the sign box.

Place the curtain retaining strip in the crease at the end of the curtain. Insert the edge of the creased curtain and the end of the retaining strip at the end of the groove in the curtain roller. Grasp the curtain and retaining strip between the thumb and index finger and slide the curtain and strip into the groove (refer to Figure 12). Resecure the ends of the curtain at the ends of the roller with short pieces of strapping tape.

6. Roll the curtain onto the empty roller until the desired reading is displayed in the sign window.

7. Replace the fluorescent light tube.

8. Put the back cover on the sign housing and secure with the four screws removed in the disassembly procedure.

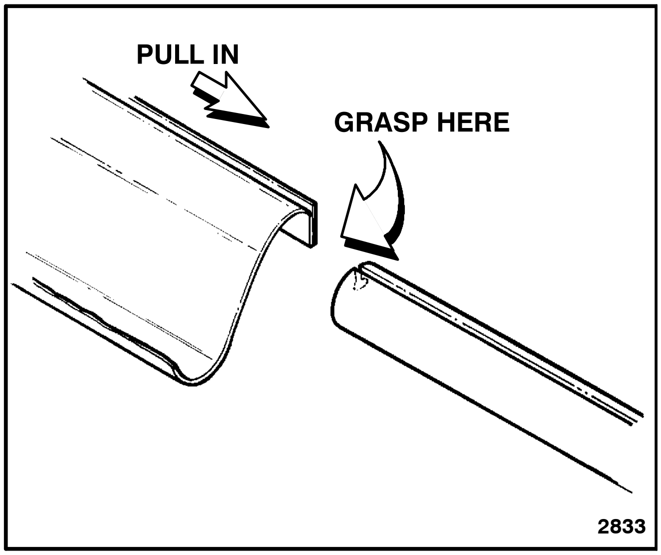


Figure 12. Installation of Curtain on Roller

SIGN INSTALLATION

1. Insert the two pins on the left-hand end of the sign into the holes in the bracket on the left-hand windshield post and push the right-hand end of the sign forward until the hooks on the right-hand end bracket enter the proper holes in the center windshield post sign mounting bracket. Lower sign slightly to allow hooks to engage the bracket.

2. Insert and turn the Dzus fastener until it engages the retaining spring in the bracket.

3. Plug the sign harness into the socket on the left-hand windshield post.

PASSENGER WINDOW BLINDS

On coaches so equipped, the passenger window blinds may be replaced and tensioned using the following procedure.

A special forceps tool, shown on the tool page at the end of this section, is required.

⚠ CAUTION ⚠

Wear safety goggles while performing this procedure.

REMOVAL

1. Use a small flat-tipped screwdriver to pry interior light lens retaining strip away from lens and parcel rack (Figure 13). Pry gently; excessive bending of the retaining strip will cause it to crack.
2. Remove trim strips at each end of the lens.
3. Remove lens cover from its outer mounting lip. The rubber keeper will come out with the lens.
4. Remove fluorescent light tube.
5. Pull the passenger window blind all the way down and fasten the handle to the underside of the window release bar.
6. Using a Phillips screwdriver, remove upper screw from left-hand window blind casting.
7. Hold the forceps tool with the key facing left and slide the key into the upper screw hole of the left-hand window blind casting and clamp the window blind roller in the forceps (Figure 14).
8. Now remove lower screw from the left-hand window blind casting.
9. Unfasten the window blind handle from the window release bar.

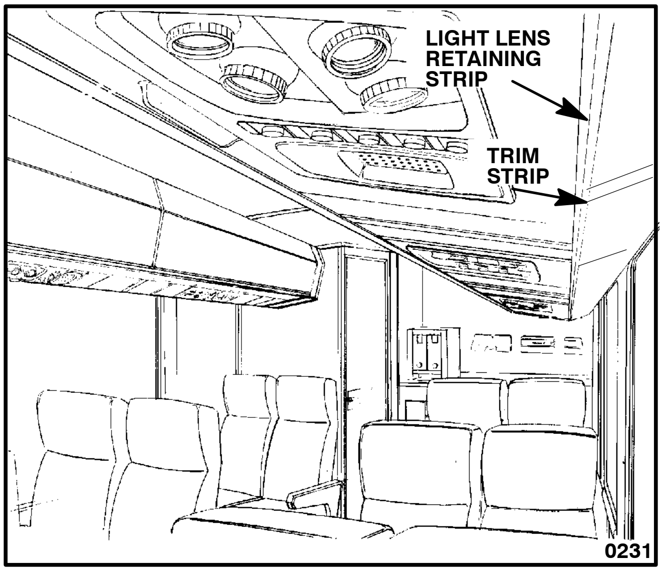


Figure 13. Light Lens Retaining Trim Strips

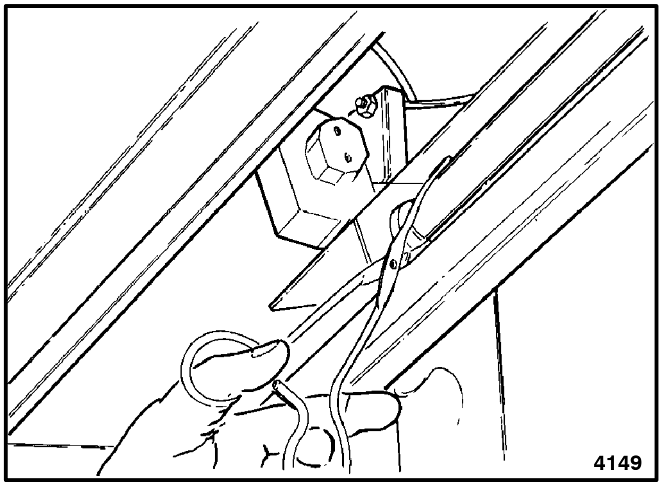


Figure 14 . Forceps Tool Clamping Roller

10. Lift the window release bar to free the window and prop the window open.
11. With the right-hand end of the window blind roller still inserted in the right-hand roller casting, pull the top left-hand end of the blind roller toward you and over the top of the lens retaining extrusion on rear of parcel rack. Hold the left-hand window blind casting on end of roller with the thumb to keep it from rotating while pulling blind over parcel rack extrusion. Continue holding left-hand casting in place and remove forceps clamp.
12. Allow left-hand casting to slowly rotate on end of the roller to release the spring tension. When tension is released, remove casting from roller.
13. Remove blind by pulling right-hand end of roller out of right-hand casting and pulling whole blind assembly over lens retaining extrusion on rear of parcel rack until roller is accessible.
14. Slide blind off of roller pulling from right to left.
15. Pull roller end of blind back over the extrusion to remove blind.

INSTALLATION

1. Install new blind by sliding roller end of extended window blind up behind lens retaining extrusion at rear of parcel rack and draping it over the extrusion (Figure 15).

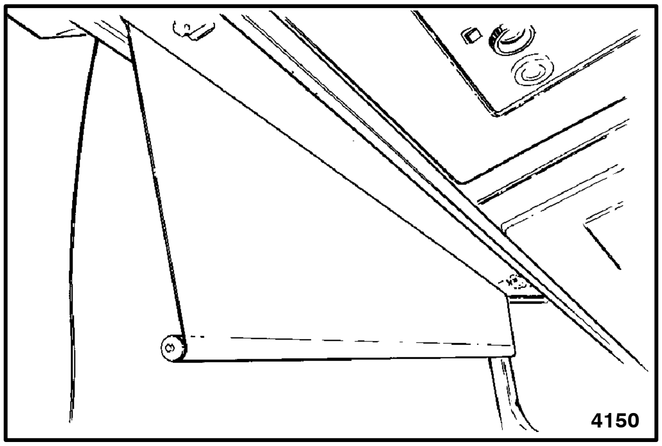


Figure 15. Installing New Blind

2. Insert left-hand top edge of blind into groove in roller, starting from right-hand end of roller. Pull blind through groove for the length of the roller.

3. Place window blind casting on left end of roller, hold roller to keep it from rotating and set roller tension by winding the casting 30 clockwise revolutions.

4. With roller tensioning done, clamp the forceps tool around the roller with the tool key inserted into the upper screw hole of the casting (Figure 16).

5. Guide right end of roller back into the right-hand casting. Then with tool key still inserted in left-hand casting and forceps clamped around the roller, match screw holes in left-hand casting to the mounting holes in the mounting bracket.

6. Run lower screw into casting and bracket. Do not completely tighten screw.

7. Secure window blind end under window release bar.

8. While holding left-hand casting in place, remove forceps tool and replace upper screw in casting and bracket. Tighten both mounting screws until snug.

9. Replace fluorescent light tube, lens cover and snap-on lens retainer molding.

10. Close and secure window with release bar.

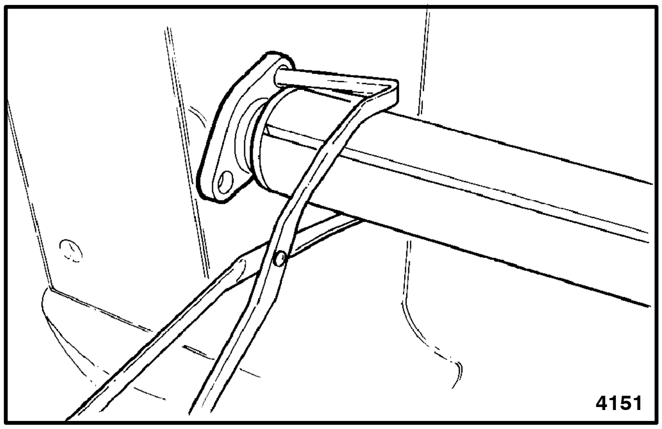
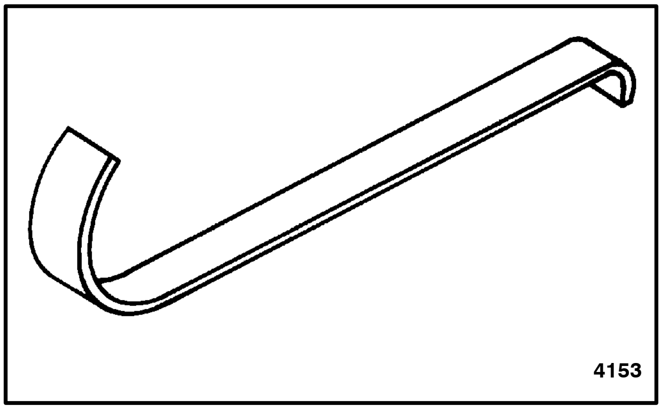


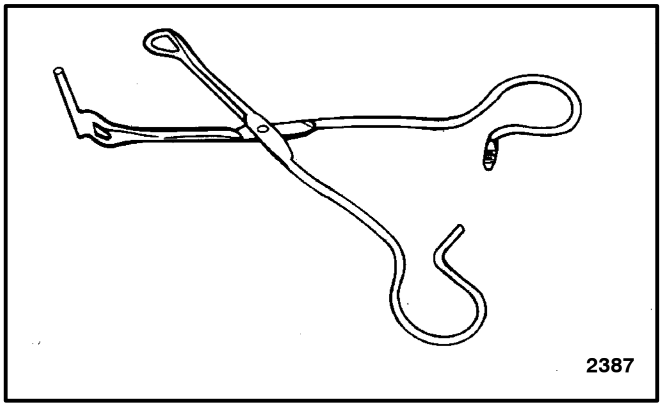
Figure 16. Installing Roller with Forceps Tool

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20 – 361: Extractor – Insert Lamp



20 -- 356: Passenger Window Blind Installation Tool

SECTION 3C1

EXTERIOR COMPONENTS

CONTENTS OF THIS SECTION

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General Description 3C1-1
Components 3C1-1
Maintenance 3C1-2
Specifications 3C1-11
Service Tools 3C1-13

GENERAL DESCRIPTION

Several different type materials are used in the construction and finishing of the coach exterior surfaces. This section will describe the general and specific maintenance requirements associated with these materials. Other related components attached to the exterior of the coach (i.e., rubber and aluminum moldings and rub rails, front and rear bumpers) will also be discussed in this section.

COMPONENTS

EXTERIOR PANELS

The basic coach exterior skin above and below the belt rail is fabricated largely from sheet aluminum. Paintable T409 stainless steel sheet is used on all rear side service door, motor door and access door exteriors, along with lower panels and trim moldings at the rear of coach. Fiberglass panels are used on the front and rear roof cap locations, tail lamp panels, lower front cap below windshield and all rear louvered panels and doors. These materials are then primed and finish painted with premium automotive coatings. Optional brush finished T304 stainless steel fluted and/or flat panels are available below the belt rails, over the front cap and at the rear of coach.

EXTERIOR COATINGS

The aluminum and T409 stainless sheet stock used on the coach exterior are factory coated with a baked-on epoxy finish. After fabrication a final coat of DuPont Imron epoxy polyurethane enamel paint is applied to the exterior and then oven baked. This combination of pre-coated and MCI factory applied paint provides the most durable and attractive finish.

NOTE: The base exterior finish color is gloss white, except at sash. Coach roof areas and all other areas not specified on the paint chart remain gloss white.

Front tire and rear engine compartment panels are finished painted gloss grey with DuPont Centari acrylic enamel. Both front and rear bogie assemblies are finished in gloss black. All trim moldings around glass and sash post caps are painted semi-gloss black. The entire underbody is coated with a silver-grey Tectyl undercoating.

SASH & BELT MOLDINGS

The sash and belt rail moldings are black rubber extrusions mounted over aluminum retaining rails. Retaining rails are riveted to coach body and secure the top and bottom edges of the sidewall panel. The exterior belt and sash rail moldings start behind the entrance door and end at the rear vertical trim moldings. Optional nonanodized (paintable) aluminum sash and belt rails may be installed instead of the basic rubber moldings. The moldings are sealed on top side with a removable rubber seal, and at the front and rear with riveted end caps.

DRIP MOLDINGS

Full length black anodized aluminum drip rails are mounted to the coach roof to sidewall intersection with screws. The 137” high roof uses a double trough extrusion with front and rear end caps. The 133” high roof uses single trough extrusions with front end plugs. Smaller trim angle type drip rails are mounted directly above the entrance door and along the LH/RH sides of windshield.

RUB RAILS

Full length 2-1/2” or optional 5” wide black rubber rub rails are mounted to panels and service doors along the lower sides of the coach. The rub rails start behind the entrance door and end at the rear bumper. Optional anodized aluminum rub rails may also be mounted to the coach. All rub rails are fastened with capscrews and are provided with end caps.

FENDERS

One and two-piece molded black rubber fender moldings are installed at front and rear wheelwell openings. The resilient type fenders are mounted with capscrews. The two-piece fenders incorporate a side turn signal lamp.

MUD FLAPS

Mud flap installations are designed to prevent rock damage and road spray during wet weather. The flaps are mounted in several locations, however, directly behind the tires is preferred. Single or full length mud flaps are available.

BUMPERS

The coach is fitted with the Help resilient rubberized hinged front bumper assembly. The bumper is mounted by capscrews directly to the coach front frame. The bumper can be unlatched and opened to gain access to the front tire compartment. The bumpers come with RH/LH body side rubber extensions, which are attached to the entrance and front side service doors. Optional silver painted or silver accent striped bumpers are also available.

The basic clear anodized rear bumper is made up of one center section, LH/RH side bumperette assemblies and LH/RH bumper end caps. The bumper, bumperettes and end caps are mounted directly to the rear frame by capscrews. An optional 5 inch black rubber rub rail can be mounted to the bumper and bumperettes. Additional top closing trim rubber is mounted to the bumper along the center section and bumperettes trim is mounted to a frame member.

An optional energy absorbing black rubber rear bumper is made up of two RH/LH center section modules and LH/RH side bumperette assemblies. The bumper and bumperettes are mounted directly to the rear frame by capscrews.

MAINTENANCE

EXTERIOR CLEANING

Regular washing to remove accumulated dust and dirt is recommended. This is all that is required on the exterior stainless steel panels below the windows. The panel caps between the windows are anodized aluminum. Avoid the use of alkaline cleaners on aluminum parts as they will attack and corrode aluminum just as iron and steel will rust. Use only a mild detergent and a soft brush. Abrasive cleaners, polish or steel wool should not be used as they will remove the protective coating and may scratch and discolor the finish. Minimum maintenance and care will keep these paints in good condition.

New Finishes

Of particular importance is the care given to the paint the first thirty (30) to sixty (60) days after the coach is painted. During this period the paint is still curing and hardening. The curing period is affected by the daily temperatures to which the coach is exposed. When daily temperatures are above 70˚F, curing will require at least 30 days. When daily temperatures are below 70˚F, at least 60 days should be allowed for curing.

⚠ **CAUTION** ⚠

High pressure washers should not be used during the curing period. Only hand washing is recommended. Damage to the paint surface can result if high pressure washers are used before the paint has fully hardened.

1. During the curing period, wash by hand only. Clean frequently using clean water rinses. If the coach exterior is extremely soiled, use a mild, neutral PH, non-abrasive detergent and clean water.
2. DO NOT use high pressure washers until the paint has cured and hardened.
3. After the curing period, high pressure washers may be used. Follow directions under “Routine Cleaning” for the appropriate distance between the pressure nozzles and the painted surface.
4. Neither DuPont Imron nor PPG Deltron paint requires waxing. Never wax DuPont Imron paint; the formulation is such that wax can cause damage to it.

Routine Washing

Wash and rinse water should be free of solids. It is especially important to assure that recirculating systems are properly designed, maintained and monitored for efficiency. In all cases suppliers of recirculating systems should provide assurance that their equipment and techniques will function satisfactorily with Lucite windows.

Two types of detergent are necessary for optimum washing efficiency. A solvent-based dissolving type of detergent should be used with the prewash spray. A highly lubricating type of detergent should be used with brushes. Detergent manufacturers should be consulted regarding recommendations on concentrations of these cleaning agents. Additionally, the water and detergent mixture should be 90˚-110˚F to improve cleaning efficiency.

Most high quality detergents contain sequestering agents and are effective in water of up to eight grains hardness. This does, of course, depend heavily on the particular detergent and its concentration. If the detergent does not contain sequestering agents, water should be softened to four grains hardness or less for effective detergent action. In all cases, the detergent supplier should be contacted for recommendations on detergent and soft water requirements.

A good, high pressure water spray prewash is vital to remove as much grit and grime as possible before brushing. Detergent may or may not be employed with the prewash. If detergent is used, follow the recommendations above, allowing enough time for the detergent to soften the grime before other washing steps. If detergent is not used in this step, please follow the directions under “Detergent Prewash” below. For alternative washer arrangements, please see Figure 1.

In cases where the initial prewash spray does not contain detergent, we recommend that a small additional spray arm be installed to cover the window area only. This arm should be located far enough from the prewash spray so that its effect is not diluted by additional water (probably 5-7 feet [1.5-2.1 m]). Alternatively, this could be located in front of the main prewash station if sufficient distance can be provided so as to allow the detergent time to act (25-40 feet at 1-2 MPH [7.6-12.2 m at 1.6-3.2 km/h]). Where possible, warm water (90°-110°F [32°-43°C]) should be used with detergent.

A wide variety of brushes can be employed for washing. Although expensive and hard to get, Tampico fibered brushes are the best. Brush filaments having a high wax content (i.e., certain polyethylenes) should be avoided since the wax leaves deposits on windows and painted surfaces. Polypropylene is normally satisfactory and may be flagged for optimum performance.

Synthetic filament is normally supplied as an “X” cross-sectional shape. Since this type of cross section can trap grit against the side, it is recommended that filament of a round or circular cross-sectional shape be used. Filament suppliers make round filament available upon request.

Many washers, particularly those with “wrap-around” features, are designed with more than one set of side brushes. Since abrasion occurs when brushes contact the coach, it is important to minimize exposure of the windows to brushing. Therefore, it is recommended that one set of brushes be deactivated from the side washing function. Where two sets of side brushes are deemed necessary, it is especially important that they be properly adjusted and maintained to minimize abrasion potential.

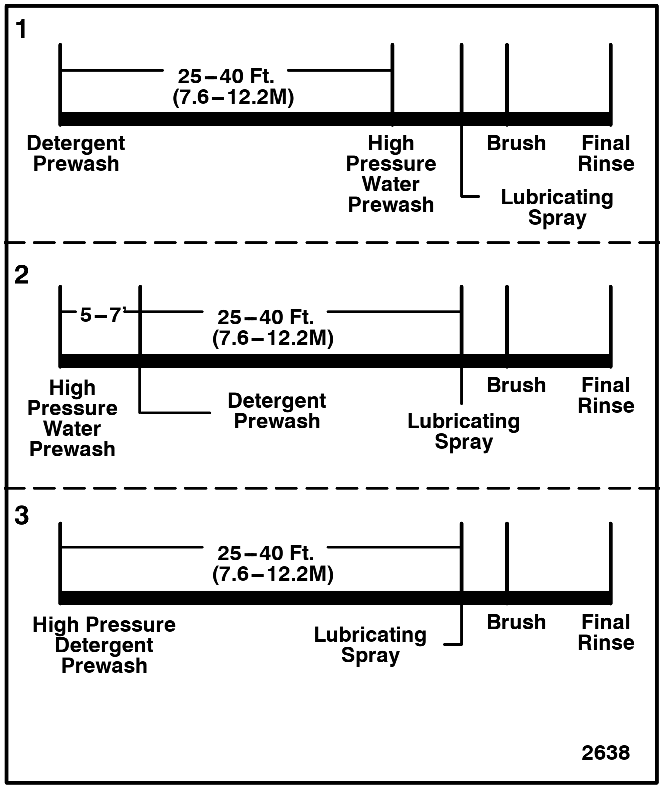


Figure 1. Washing Equipment Schematic.

Brush pressure and amount of filament in contact with the coach are the two factors most damaging to windows of Lucite SAR and to painted coach surfaces. Normally, the amount of filament in contact with the window and brush pressure are directly proportional to one another. As brush pressure is lowered, the amount of filament in contact with the window is less. Total pressure should be as low as possible. It is most important that no more than six inches of filament overlap the bus side as the brush turns. Speed of the coach through the prewash, wash and rinse should be 1-2 MPH (1.6-3.2 KPH). The bus should never be stopped while in contact with the brushes.

Many washers already include a rinse spray to clean grit from the brush. This should be retained and its position optimized to do the most effective job. The final rinse should be a high pressure, high volume (with emphasis on the high volume) rinse with a minimum delivery of 125 GPM (473 L/minute).

Conventional techniques may be used to clean Lucite SAR. However, care should be taken to use a clean, soft (unsized) cloth. The surface of the window should be wetted with the cleaning solution before wiping. When oily surface contamination is present, the cleaning solution may not wet the surface thoroughly until it is rubbed with the cloth.

NOTE: The less filament in contact with Lucite SAR, during brush wash will guard against scratches during cleaning. It may be necessary to provide a soft roller or wheel guide on the brush arm to prevent over-pressure of brush.

Household cleaners which have been tested and found effective in cleaning Lucite SAR include Easy-Off, Windex, Glass Plus, Top Job, Mr Clean and Fantastik. Industrial cleaners effective on the acrylic windows are Neleco Subway Soil Solvent (Neleco Products, Inc.) and C-1102 Alkaline Cleaner (DuBois Chemicals).

To remove paint, ink marks and graffiti which are resistant to household cleaners, use a soft cloth saturated with isopropanol or an aliphatic hydrocarbon solvent. Do not use abrasive cleaners. Avoid using razor blades or other sharp instruments which might gouge the surface.

Two commercially available antistatic cleaners which effectively clean Lucite SAR windows and reduce the tendency for static charge build-up are “Like-Magic” Type N1-5, Merchandise Presentations, Inc., 3960 Merritt Avenue, New York, NY, 10466 and “Trend” Antistat Cleaner, Dawn Products, P.O. Box 24, Englewood, CO, 80110. Follow the manufacturers’ instructions when using the antistatic cleaners.

Corrosion Prevention

The entire underside of the coach is sprayed with a heavy application of tectyl base undercoating, and additionally, all fasteners are corrosion resistant. The type of operating environment to which a coach is exposed determines the amount of dirt and corrosion that will accumulate over any given operating period. Corrosion is an item that can be controlled when it is conscientiously looked for and the proper steps taken within a reasonable amount of time. Preventive maintenance is a key factor in avoiding corrosion and must be considered as part of the regular service intervals.

IMPORTANT: Failure to properly maintain the coach lower body surfaces and structural components may void the coach warranty.

Certain areas of the coach are more vulnerable to corrosion than others and it is these areas that should be addressed. For example, the rear baggage compartment bulkhead in the rear wheelhousing area should be examined regularly for corrosion. This location contains many key components: relay valve, suspension air filter, dry air tank, inversion valve, parking brake, pressure regulator, and numerous other valves and fittings. Other areas include the front wheelhousing area, spare tire compartment, front left side service area, and engine compartment.

Road splash will affect undercarriage, sides of coach, fresh air intakes, condenser coil and engine compartment. These areas must be thoroughly cleaned to remove “dirt packs” from flanges, channel and ledges. These places accumulate dirt and salt and hold it in direct contact with steel and aluminum surfaces. Use an understructure high pressure spray as part of a regular wash. Damaged undercoating or paint should be promptly repaired before corrosion can start.

Frequency of wash periods depends on operating conditions. During periods of exposure to salt daily washing as described above is necessary.

If underbody parts show evidence of rust or corrosion, treat as follows:

1. Clean. Remove dirt, grease and oil by solvent washing.
2. Remove corrosion as well as all loose tectyl coating by sanding with wire brush or by other means.
3. After removing all corrosion, correct priming, painting and undercoating must be reapplied to prevent further damage.

⚠ **CAUTION** ⚠

Sandblasting can be used for cleaning bulkheads, brackets and other structural members. It should not be used for exterior side paneling. Extreme care should be taken not to sandblast excessively.

STRUCTURAL WELDING

NOTE: Refer to the welding caution in the introductory pages of this manual before starting any welding operation. All welding must conform to D1.1 of the AWS Structural Steel Welding Specification.

The entire suspension bogie frame structures are of a welded design. The high-strength Corten steel front and rear bogie assemblies are jig welded to ensure proper alignment of the main radius rod attaching points.

All of the lower frame components including truss frames are manufactured from stainless steel. This prevents rust and corrosion from occurring on the frame members due to moisture and road salts. Welded repairs to these components can also be carried out in a conventional manner.

NOTE: Refer to the welding rods applications table in Specifications section when making welding repairs to the body structure

PANEL REPLACEMENT

Replacement of either metal or fiberglass body panels will generally require removal of rivets, metal screws or capscrews. Aluminum rivets can be removed by drilling out the rivet with a drill slightly smaller than the body of the rivet. When drilling out pop rivets, always push out the stem first.

There are a number of types of rivets used in the manufacture of the coach. A general classification of these types can be found in the rivet charts at the end of this section

Should replacement of fiberglass roof or front lower cap panels be required, it is recommended that the new panel be fitted to the old panel and marked from the underside in the areas where rivet holes are located.

1. If the roof bow channels are bent or damaged, they should be altered or replaced in order to match the contours of the fiberglass panel. Some areas may require shims. The location and necessary thickness for each shim should also be marked for required additions.

2. The panel should then be removed and sanded in the marked areas in order to roughen the mounting surfaces. Apply Dolphinite sealer to the channel mounting surface and the sanded area of the fiberglass panel. Place and clamp panels in place complete with any necessary shims. Inspect the panel for proper fitting.

3. Drill holes through the panel from the underside of the channel. Existing holes in the roof bow channel may be used as a template.

> **NOTE:** Only drill 4-5 holes at one time. Do not attempt to drill all the holes and then rivet. Prior to riveting, check to ensure that misalignment and gapping have not occurred.

Hand-type guns for pulling cherry rivets and lazy tongs for Imex and “Pop” are available for repair work. Contact Service Parts department for information.

> **NOTE:** Most panel repairs or replacements will require a sealant of some kind. Refer to the Parts Manual for appropriate materials.

FIBERGLASS REPAIRS

All repairs to fiberglass panels or caps will generally consist of reinforcement of cracked or broken areas. Fiberglassing the back or underside of a damaged panel may allow it to be refinished and painted. Large holes, torn sections and separated joints require the reinforcement qualities of a layed-up cloth and resin repair. The repair is allowed to harden and then the finishing operations are performed. Small exterior depressions, scratches or pits can be repaired using ordinary body putty.

⚠ CAUTION ⚠

Always use protective rubber gloves and masks when working with resins. Some people experience a skin reaction to resins. If this happens, wipe off skin with denatured alcohol or clean thinner. There are several protective hand creams available and their use is recommended.

If any disc grinding or sanding is to be done in an enclosed area, a respirator should be used and goggles should be worn.

Extreme care must be taken if the sander is electrically operated as dust of some resins is combustible when subjected to sparks or open flame. The proper tool for sanding resin is a low speed, air driven disc sander with a water attachment or a dry sander having a vacuum bag attachment. Either will eliminate fiberglass and resin dust.

The following additional tools and materials will assist in making repairs. Hacksaw blade, assorted files, emery paper or cloth (No. 150 grit or finer), scissors or tin snips, wax paper or cellophane sheets, small 3 inch (76.2 mm) grooved roller, paint brush, putty knife, acetone and one or more heat lamps. For best results the ambient temperature should be 70-75°F (21-24°C) when making repairs.

1. Remove all loose particles or damaged material using a power sander or rasp and where necessary sand paint away.

2. Grind or file the damaged area to form a “V” at the broken or cracked portion. Sides of the “V” should have a shallow pitch for maximum bonding area.

> **NOTE:** Roughening the surface improves adhesion of resin.

3. If paneling is warped, use C clamps and improved clamp plates to align surfaces. Preheat area to be repaired using one or two heat lamps positioned 12-15 inches (305-381 mm) from repair area.

⚠ CAUTION ⚠

200°F (93°C) is the high limit for this material. To go higher is to risk material distortion or crystallizing.

4. Cut a piece of fiberglass 1-3 inches larger than the area to be repaired and impregnate with general purpose polyester resin catalyzed with MEKP9.

NOTE: Mix the desired quantity of resin and hardener in proportions of 1/2 tablespoon hardener to one quart resin. Do not use wax cups for mixing, and prevent contamination between resin and hardener cans.

5. Place the impregnated mat over the hole or crack. Using a clean paint brush, apply resin and press mat onto the surface with the brush to obtain good adherence. Another coat of resin may be applied at this time. Alternate layers of mat and cloth saturating each layer of fiberglass as it is placed over the damaged area. Smooth out the wrinkles while ensuring that the general contour of the area is maintained. Bubbles and wrinkles can be rolled out using the grooved roller.

6. When the required strength and thickness is obtained, allow the area to harden. Allow sufficient time for the patch to cool off properly before proceeding.

NOTE: Be sure all air is removed from between surfaces being joined.

⚠ CAUTION ⚠

Once the resin and hardener have been mixed, the pot life (working time) of the mix is approximately 15 minutes. Any accidental contamination to the skin, clothing, tools, etc., must be removed within this period. Use acetone to remove uncured resin.

7. Heat resin material again placing lamps 12-15 inches (305-381 mm) from repaired area. Allow 12-15 minutes for repair to cure.

8. After repair is cured, grind, file or sand to contour. Files other than body files may be more suitable. Feather edge and finish sanding.

9. After rough sanding, small pits or irregularities may appear in the finished surface. Repair following the instructions under Fiberglass Paste Repairs. Smooth off the surface with 100 sandpaper and finish with 120 sandpaper. Reprime and repaint according to appropriate painting instructions.

SURFACE PREPARATION

The following surface prep specifications cover refinishing of both bare metals and fiberglass as well as painted metals and fiberglass.

NOTE: If sheet metal parts are purchased from Universal Coach Parts Inc., Des Plaines, Illinois or in Canada from Motor Coach Industries, Service Parts Division, Winnipeg, Manitoba or Newcastle, Ontario they will be forwarded in a primed condition. It is then only necessary to apply finish coats as outlined.

Carbon & Corten Steel

1. Surface Preparation - Wash with 3812S Enamel Reducer and wipe dry with clean cloths.

2. Apply 5717S Metal Conditioner - In a plastic container, mix 5717S Metal Conditioner with two parts water and apply to the surface with a cloth or sponge; if rust or corrosion is present, use a Scotch-Brite or similar abrasive pad. While still wet, wipe dry with clean cloths.

3. Apply 224S Conversion Coating - In a plastic container and without dilution, use a Scotch-Brite or similar pad and apply to the treated metal surface. Leave on the surface 2-5 minutes. Work only as much area as can be coated and rinsed before the solution dries. Reapply if surface dries before rinsing. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water. Wipe dry with clean cloths or air dry. Apply primer.

4. Apply 825S Corlar Epoxy Primer.

NOTE: Allow heavy components such as wheel hubs to come to room temperature prior to painting. Condensation could cause a lack of paint adhesion.

Stainless Steel

1. Surface Preparation - Wash with 3812S Enamel Reducer and wipe dry with clean cloths. Fine particle sand blast or sand well.

2. Apply 5717S Metal Conditioner - In a plastic container, mix 5717S Metal Conditioner with two parts water and apply to the surface with a cloth or sponge; if corrosion is present, use a Scotch-Brite or similar abrasive pad. While still wet, dry with clean cloths.

3. Apply 224S Conversion Coating - In a plastic container and without dilution, use a Scotch-Brite or similar pad and apply to the treated metal surface. Leave on the surface 2-5 minutes. Work only as much area as can be coated and rinsed before the solution dries. Reapply if surface dries before rinsing. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water. Wipe dry with clean cloths or air dry. Apply primer.

4. Apply 825S Corlar Epoxy Primer.

Aluminum

1. Surface Preparation - Wash with 3812S Enamel Reducer and wipe dry with clean cloths.

2. Apply 225S Aluminum Cleaner - In a plastic container, mix 225S Aluminum Cleaner with two parts water and apply to the surface with a cloth or sponge; if rust or corrosion is present, use a Scotch-Brite or similar abrasive pad. While still wet, wipe dry with clean cloths.

3. Apply 226S Conversion Coating - In a plastic container and without dilution, use a Scotch-Brite or similar pad and apply to the treated metal surface. Leave

on the surface 2-5 minutes. Work only as much area as can be coated and rinsed before the solution dries. Reapply if surface dries before rinsing. Rinse by flushing the surface with cold water or mop with a damp sponge or cloth rinsed occasionally in clean water. Wipe dry with clean cloths or air dry. Apply primer.

4. Apply 824S/825S Epoxy Primer.

Fiberglass

1. Surface Preparation - Wash the surface with 3819S PrepSol. While still wet, wipe dry with clean cloths.

2. Sand thoroughly, clean and apply 824S/825S Corlar Epoxy Primer.

PAINT COMPONENTS

MCI model coaches are painted with DuPont Imron paint. This two part epoxy high-gloss polyurethane enamel finish is designed for exposure to extreme conditions. The two part product is comprised of a pigmented base and an activator. Companion products include an optional dry time accelerator, an additive to eliminate fisheyes, and reducer are described below.

ACTIVATOR - Imron must be activated with 192S Activator. Ratio: 1 part 192S Activator to three parts Imron. Mix thoroughly.

ADDITIVES - 189S Dry-Time Accelerator - to be used for faster tape-free time. Ratio: up to four ounces of 189S to one gallon of mixed Imron.

FISH EYE ELIMINATOR - when necessary, use 259S to eliminate fish eyes. Use up to two ounces per gallon.

REDUCERS - 8485S used to reduce Imron to a viscosity of 18-22 seconds in a DuPont M-50 Viscosity Cup. 8100S used as an Imron retarder.

NOTE: Clean all equipment with 3602S Lacquer Thinner or 8485S Reducer immediately after use.

AIR PRESSURE - 50 psi “at the gun” for solid colors; 65 psi “at the gun” for metallic colors.

⚠ CAUTION ⚠

Care should be exercised in storing, handling, mixing and applying Imron paints and chemical materials listed in this manual. The topcoat, primer, solvent, accelerators, activators and cleaners are highly volatile and/or toxic. In addition to observing the safety instructions listed on the packaging, the following safety precautions should be observed.

1. No smoking in the paint room or any adjacent area exposed to residue fumes.

2. Only NIOSH (National Institute for Occupational Safety and Health) approved respirators should be used.

3. Adequate ventilation must be maintained.

4. Wash hands prior to eating.

5. Wear rubber gloves, rubber apron, and face shield during all phases of paint and chemical handling.

6. If available, operator supplied air (Independent Breathing Apparatus) should be used.

PAINT APPLICATION

NOTE: Always follow the manufacturer’s application instructions closely for best results.

Prime Painting (Bare Surface)

825S Corlar Epoxy Primer (red) is our recommendation for prime coating of bare steel, stainless steel and aluminum surfaces. 824S Corlar Primer (gray) is our recommendation for bare fiberglass and may also be used on aluminum.

ACTIVATION - to two parts 824S/825S Primer, add one part 826S Activator.

INDUCTION PERIOD - allow activated primer to stand one hour at 70˚F (21˚C) and above; two hours when temperature is below 70˚F (21˚C). This will allow the chemical reaction to take place.

POT LIFE - Three days at 70˚F (21˚C).

REDUCTION - Reduce activated primer 33% by volume (ratio 3-1) with 3602S Lacquer Thinner, or to a viscosity of 21-24 sec. in a DuPont M-50 Viscosity Cup or equivalent.

APPLICATION - Using 45-55 psi “at the gun,” spray one full wet coat to give a dry film thickness of 0.7-1.0 mils.

DRYING TIME - Depending on temperature and film thickness 2-6 hours may be required. Overnight drying may be necessary when two or three coats have been applied and/or when temperatures are low.

Prime Painting (Previously Coated Surface)

1. Wash the painted surfaces with soap and water to remove dirt and water-soluble contaminants.

2. Wipe the painted surfaces with 3919S Prep-Sol to remove wax, grease and other contaminants. While solvent is wet, wipe dry.

3. Repair flaws in the painted surface by grinding off paint in the damaged areas and fill in body filler, if necessary. Featheredge ground-off areas by machine or hand sanding. Treat bare metal areas with the appropriate conditions and conversion coatings.

4. Apply 824S, 825S, 100S or 110S as recommended above.

825S Corlar Epoxy Primer (red) is our recommendation for priming or spot priming previously painted surfaces where the metal substrate is steel, stainless steel or aluminum. 824S Corlar Epoxy Primer (gray) is our recommendation for priming or spot priming previously painted surfaces where the substrate is fiberglass (can also be used on aluminum).

ACTIVATION - To two parts 824S/825S Primer, add one part 826S Activator.

INDUCTION PERIOD - Allow activated primer to stand one hour at 70˚F (21˚C) and above; two hours when temperature is below 70˚F (21˚C). This will allow the chemical reaction to take place.

POT LIFE - Three days at 70˚F (21˚C).

REDUCTION - For spot repairs, reduce the activated primer 20% by volume (ratio 5-1) with 3602S Lacquer Thinner.

APPLICATION - Using 45-55 psi "at the gun," spray until satisfactory filling is achieved (2-4 coats).

DRYING TIME - With this heavier mixture, drying time will be extended to 4-8 hours and overnight drying may be necessary.

100S Gray/110S Red Oxide Multi-Purpose Acrylic Lacquer Primer may be used as an alternate priming system for making spot repairs on small bare metal areas. Metal to be treated as described above.

REDUCTION - 80-125% by volume (ratio 1-1) to a viscosity of 23-24 sec. on a DuPont M-50 Viscosity Cup or equivalent with 3661S Lacquer Thinner in the the mid-temp ranges and 3602S Lacquer Thinner during warm weather.

APPLICATION - Using 35-45 psi "at the gun," spray three or more coats as needed. Allow each coat to completely flash.

DRYING TIME - Allow to dry thoroughly before sanding (30-60 minutes).

Finish Painting (Metal Surface)

On non-metallic solid colors it is best to spray a medium first coat. Allow it to become tacky and follow with a full second coat. For metallic colors, spray three light to medium coats. After hiding has been achieved, reduce activated Imron 15% with 8485S Imron Reducer. Apply one or two mist coats to improve flow out and reduce mottling.

Two tone paint schemes can be done in approximately 6-10 hours, if temperatures are at 77˚F (25˚C) with no more than 50% humidity. If the189S Accelerator is used, this process can be done in 2-4 hours minimum at 70˚-75˚F (21˚-24˚C).

Finish Painting (Rubber Surface)

Exterior rubber parts may be painted or repainted using the procedures listed below.

1. If item being painted is new, prepare surface to be painted by sanding with #320 paper. If item has been painted previously, remove old paint only by sanding; **DO NOT** use paint removing solvents as they will cause deterioration of the rubber and impair the adhesion of the new paint.

> **NOTE:** Additionally, at no time in the process of painting or repainting the rubber part is alcohol or solvents containing alcohol to be used on the rubber. The alcohol attacks the rubber and causes poor adhesion of "Imron" paint.

2. After sanding, wipe the surface with DuPont T-3812 solvent. This solvent does not affect the rubber or interfere with the paint adhesion.

3. Apply DuPont "Imron" paint directly to the freshly prepared surface. Use the recommended activation and reduction as described earlier in "Paint Components".

DECAL APPLICATION

The following drying times should be observed to prevent blistering when applying decals over Imron paint. Overnight drying following 30 minutes drying at 180˚F (82˚C), 60 minutes drying at 140˚F (60˚C) or 120 minutes drying at 110˚F (43˚C). If sufficient time and temperature is allowed in the cure of the Imron, it is possible to apply decals to the Imron surface without experiencing the blistering effect.

SASH & BELT MOLDINGS

Sash and belt rail moldings may be easily removed from the coach retaining extrusion for replacement or to gain access to the sidewall panel. Black rubber moldings are installed as basic. The optional aluminum molding are installed with some paint schemes.

> NOTE: Coaches prior to unit #45959 have belt rail molding extending around rear corners and across rear doors.

Removal

When removing the rubber moldings or intermediate plastic insert on the aluminum moldings it is best to have the coach in a warm area. Application of a soap solution may help in the removal and installation process of both types of moldings.

RUBBER

1. Turn battery disconnect switch to “OFF” position.

2. Pull rubber molding end back away from end cap and retain to expose the end cap mounting screw and rivet.

> **NOTE:** It unable to pull rubber away from end cap, it may be necessary to destroy the end cap or to deform and remove rubber from the middle of the rails length.

3. Unfasten the end cap and pull the molding off of retainer extrusion.

ALUMINUM

1. Turn battery disconnect switch to “OFF” position.
2. Unfasten the screw holding end cap in place.
3. Remove the top rubber seal from the molding.
4. Insert hooked device and pull the intermediate plastic insert from between the aluminum molding and retaining extrusion.
5. Match mark both moldings and inserts for reinstallation.
6. Remove the aluminum molding from the retainer extrusion.
7. Continue this procedure until all sections of molding have been removed

> **NOTE:** Curved molding sections do not have the plastic inserts.

Installation

1. Reinstall in the reverse order of the “Removal” procedure.

> **NOTE:** When installing the rubber moldings and seals, make sure enough material has been compressed into the length to keep it from shrinking during cold weather.

DRIP MOLDINGS

Drip moldings may be easily removed from the coach for replacement or to gain access to the roof panel. Black anodized aluminum moldings are installed as basic. Drip moldings are retained by screw and two-sided tape.

Removal

1. Turn battery disconnect switch to “OFF” position.
2. Unfasten and remove all screws holding end caps and molding in place.
3. Gently remove the molding from the roof panels.
4. Clean tape from the drip moldings.

Installation

1. Apply two-sided tape to the backs of drip molding sections prior to installation.
2. Apply sealant at screw locations and reinstall moldings.

> **NOTE:** Use P/N 19-1-1356 screws if holes are stripped.

RUB RAILS

The 2-3/4” wide black rubber rub rail moldings are installed as basic. Optional 5” wide black rubber moldings are installed with stainless panels and some paint schemes. The rubber rub rails are installed with a single row of fasteners.

The optional 9” wide clear anodized aluminum rub rail moldings are installed with conversion coaches, stainless panels and some paint schemes. The aluminum rub rails are installed with a double row of fasteners and have an upper rubber seal..

Removal

When removing the rubber rub rail moldings, it is best to have the coach in a warm area. Application of a soap solution may help in the removal and installation process of rubber molding materials.

2-3/4” RUBBER RUB RAILS

1. Turn battery disconnect switch to “OFF” position.
2. Unfasten and remove the solid rub rail pieces screwed to the intermediate post or panel sections.
3. Pull the rubber rub rail molding back away from end cap and retain to expose the end cap mounting rivets. Drill out rivets and remove caps.
4. Unfasten mounting hardware from back of door or panel and remove rubber rub rail and retaining extrusion assembly.

> **NOTE:** Some rubber rub rails attached to panels at rear of rear side service door may be pulled off the retainer extrusion after end cap is removed. Retaining extrusion’s mounting rivets may then be removed.

5” RUBBER RUB RAILS

1. Turn battery disconnect switch to “OFF” position.
2. Remove screw hole plugs from the intermediate post or panel rub rail sections and unfasten the solid rub rail pieces.
3. Unfasten mounting hardware from back of door or panel and remove rubber rub rail and retaining extrusion assembly.

ALUMINUM

1. Turn battery disconnect switch to “OFF” position.

2. Remove lower screws from the intermediate post or panel rub rail sections and unfasten from upper retaining clips.

3. Unfasten mounting hardware from back of door or panel and remove aluminum rub rail assembly.

NOTE: Pry out and remove the end caps from rub rail assembly sections. Rubber rub rail material can be separated from the retaining aluminum channels and extrusions. Upper and lower seal material can be removed from the aluminum rub rails.

Installation

1. Reinstall in the reverse order of the “Removal” procedure.

NOTE: When installing the 2-3/4” rubber rub rails, make sure enough material has been compressed into the length to keep it from shrinking during cold weather.

FENDERS

Fenders can be easily removed from coach exterior panels for replacement. The single front and dual rear black rubber fenders are installed as basic. The rear fenders have a side turn lamp assembly installed.

Removal

1. Turn battery disconnect switch to “OFF” position.

2. Unfasten and disconnect turn lamp from fender assembly.

3. Unfasten mounting hardware from inside of wheelwells retaining/joining strips and remove flaps.

Installation

1. Reinstall in the reverse order of the “Removal” procedure.

MUD FLAPS

The standard single black rubber mud flaps can be installed at front and rear locations. Front and rear installations are located on their respective rear wheelwell panels. A single mud flap may also be installed between the drive and trailing axles. Optional full width black rubber flaps can be installed at the rear location ahead of rear bumper.

Removal

1. Turn battery disconnect switch to “OFF” position.

2. Unfasten and remove mounting hardware retaining rubber flaps and metal strip and remove .

Installation

1. Reinstall in the reverse order of the “Removal” procedure.

BUMPERS

The basic front hinged front bumper assembly has a two-piece black rubber module fitted to a single support channel. Basic wide black rubber front bumper extensions are attached to the entrance and front side service doors.

The basic rear bumper is a single heavy aluminum blade with rubber rub rail attached. Rear bumperettes are attached to the RH/LH sides of coach. The energy absorbing rear bumper assembly has a single-piece black rubber module fitted to a single support channel. The rear bumperettes also attach to the coach sides. A top trim rubber is attached to the bumper’s top closing panel and to the rear corner frames.

NOTE: Effective with unit 47262, new rear energy absorbing bumper assemblies with overlapping rubber seams are used.

Removal

Bumper assemblies with rubber modules and support structure can be removed as an assembly. The rubber module may then be disassembled and replaced.

FRONT BUMPER

1. Turn battery disconnect switch to “OFF” position.

2. Release bumper latch and allow it to swing open and lock. Position blocks to support bumper when unfastened.

3. Unfasten and remove the splash boot at bottom of bumper.

4. Release spring tension, and remove the spring retaining pins. Unfasten and remove the latch assembly.

5. Unfasten and remove the mounting capscrews from top and bottom locations and remove bumper.

Installation

1. Reinstall in the reverse order of the “Removal” procedure. Readjust spring tension and shim bumper as necessary.

REAR ALUMINUM BUMPER

1. Turn battery disconnect switch to “OFF” position.

2. Unfasten and remove the trim rubber attached to the center bumper top and from corner frame.

3. Unfasten and remove the two mount capscrews just inside the motor doors, and remove the bumper blade.

4. Unfasten and remove the corner bumperettes and trim caps.

Installation

1. Reinstall in the reverse order of the "Removal" procedure. Shim bumper as necessary.

REAR ENERGY ABSORBING BUMPER

1. Turn battery disconnect switch to "OFF" position.
2. Unfasten and remove the trim rubber attached to the center bumper top and from corner frame.
3. Unfasten and remove the top cover panel. Position blocks to support bumper when unfastened.
4. Unfasten and remove the top and bottom mounting capscrews, and remove the bumper.

Installation

1. Reinstall in the reverse order of the "Removal" procedure. Shim bumper as necessary.

SPECIFICATIONS

FRONT BUMPER ASSEMBLY

Manufacturer	Romeo-Rim
Part Number	3J-21-6

REAR BUMPER ASSEMBLY

Manufacturer	Romeo-Rim
Part Number (Basic)	3K-21-3
Part Number (Energy Absorbing – Effective with Unit #47262)	3L-21-181

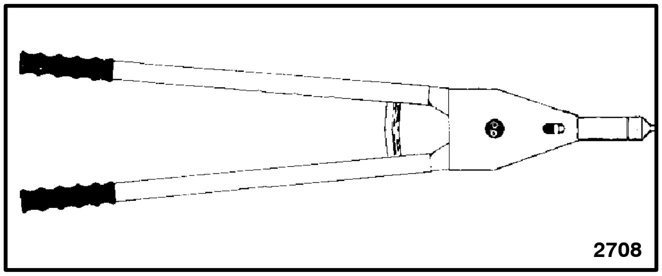
FILLER METALS

APPLICATION	DIAMETER.	A.W.S
SS to SS or Corten, Light Gauge	3/32 Inch (2.4 mm)	No. 308
SS to SS or Corten, Heavy Gauge	1/8 - 5/32 Inch (3.2-4.0 mm)	No. 308
Corten to Corten, Light Gauge	3/32 - 1/8 Inch (2.4-3.2 mm)	No. 6011
Corten to Corten, Heavy Gauge	3/32 - 5/32 Inch (2.4-4.0 mm)	No. 7018
Air Beam Reservoirs, Heavy Plate Sections	5/32 Inch (4.0 mm)	No. 7018

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.

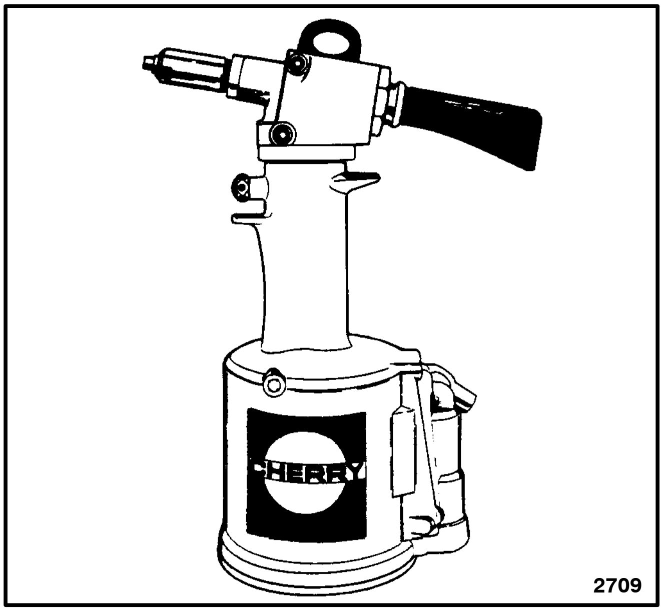
HAND RIVET GUN (AVDEL NO. 165)



2708

20 - 171: (C/W tip for 1/4 inch Monobolt Rivets)

POWER RIVETER (GH743) 20-160



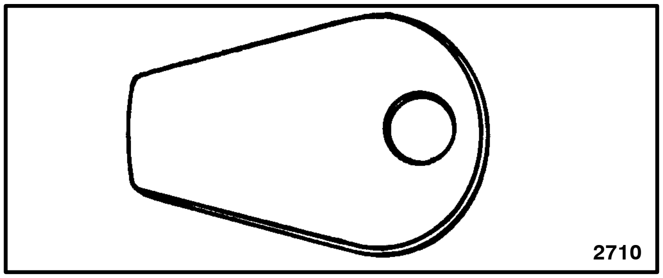
2709

(also available, lighter duty No. GH703 not shown)

20 - 170: Nosepiece - 1/4” Monobolt Rivet

20 - 161: Pulling Head - 3/16” Cherry “N” & Cherry “Q” Rivets

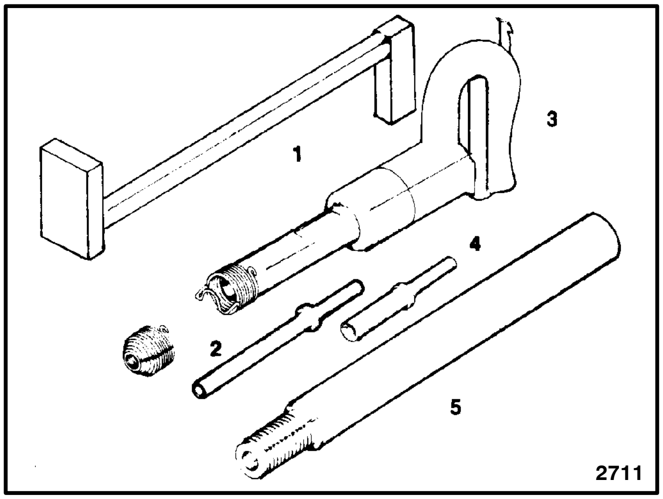
20 - 162: Pulling Head - 3/16” Cherry “C” Rivets



2710

3J-15-150: Dzus Tool

Bucking or Squeezing

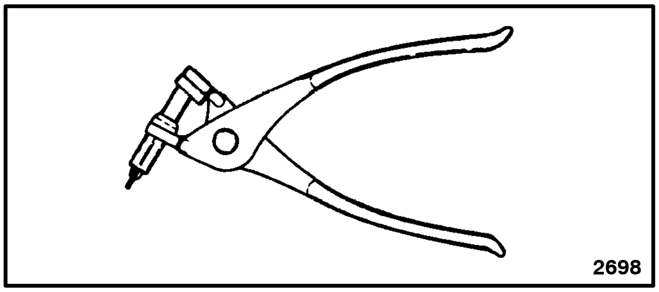


2711

20 - 7: Buck Riveting Tool Kit - for brazier head, universal head, round head and flat head rivets of aluminum, steel or copper.

Consists of:

1. Rivet Bucking Foot
2. 5/32” Brazier Head
3. CP-4444 “A” Pneumatic Hammer Pistol Grip
4. 7/32” Brazier Head
5. Bucking Dolly Tool Holder

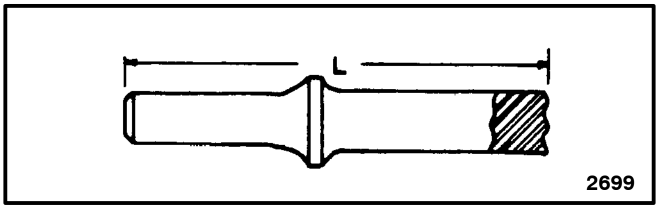


20 - 10: Panel Clamping Kit - Consists of:

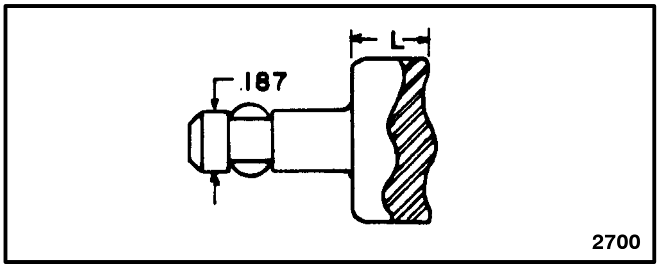
1. Wedge Lock Clamp 1/4 inch used to hold panels in place.
2. Wedge Lock Pliers for applying Clamp.

The following tools are required when replacing Stainless Steel Semi-Tubular Rivets.

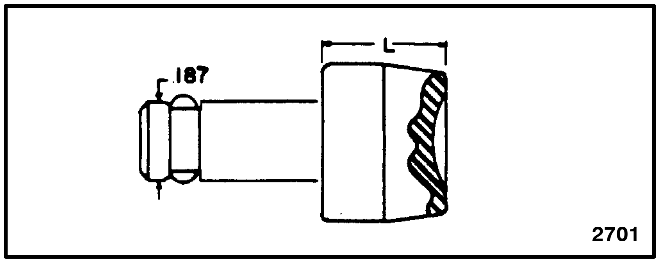
CP-4444A Pneumatic Hammer Pistol Grip.



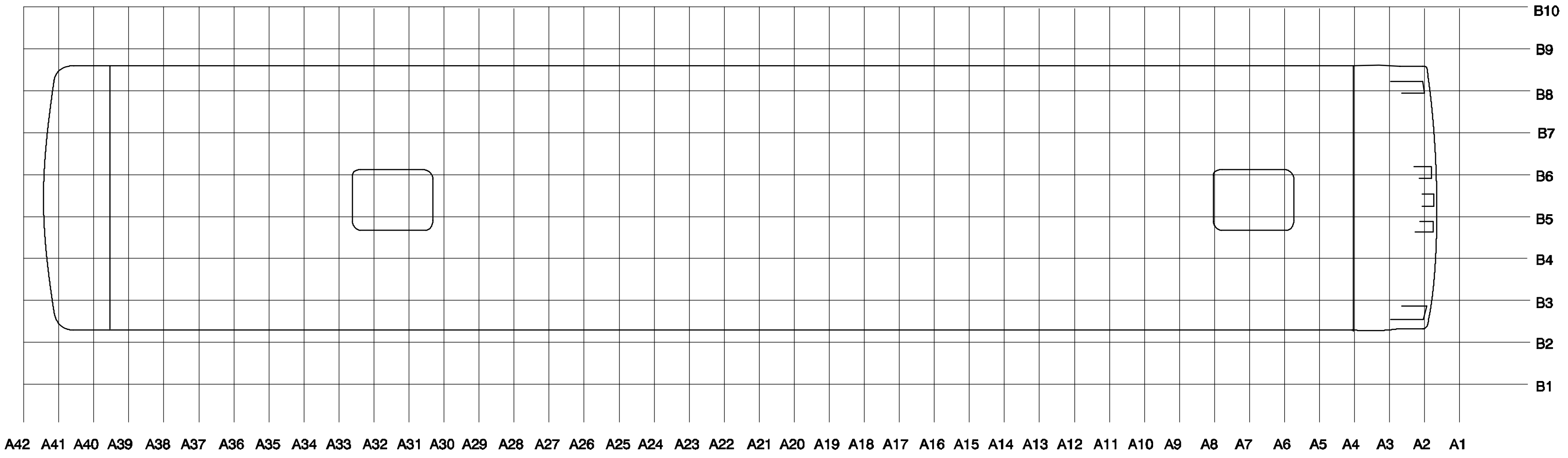
20 - 125: CP-4444A Rivet Gun Drive Set
3-1/2 inches Long (88.9 mm)
20 - 126: CP-444A Rivet Gun Tool Drive Set
5-1/2 inches Long (139.7 mm)



20-127: CP-444A Rivet Gun Flaring Squeezer Set
1/4 inch Long (6.35 mm)
20 - 128:CP-4444A Rivet Gun Flaring Squeezer Set
3/8 inch Long (9.52 mm)



20 - 129: CP-4444A Rivet Gun Cupped Squeezer Set
1/4 inch Long (6.35 mm)
20 - 130: CP-4444A Rivet Gun Cupped Squeezer Set
3/8 inch Long (9.52 mm)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B9
B8
B7
B6
B5
B4
B3
B2
B1
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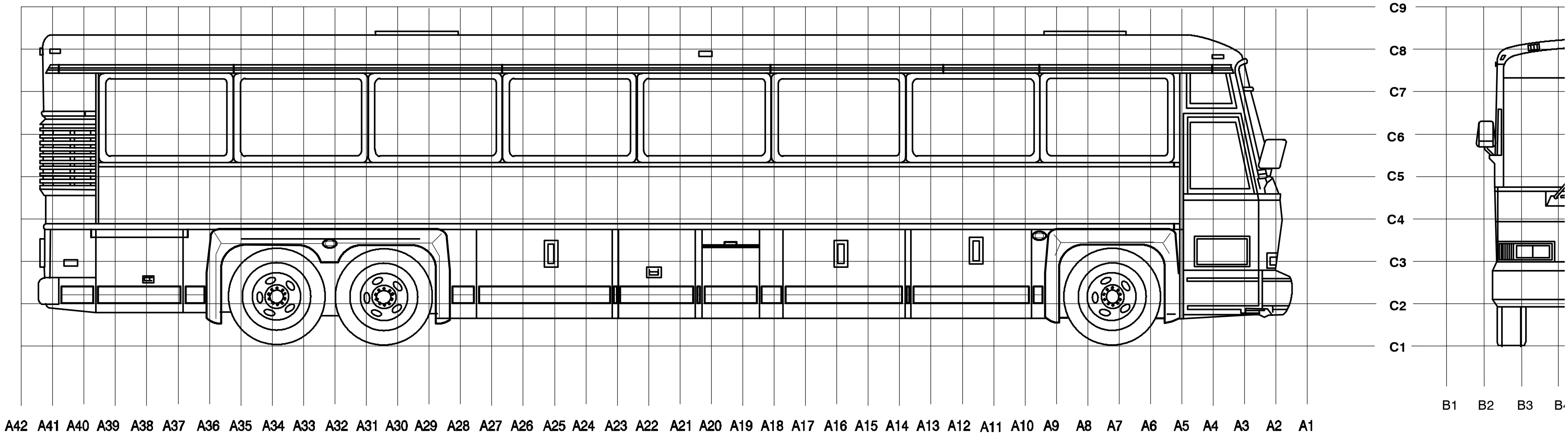
C9
C8
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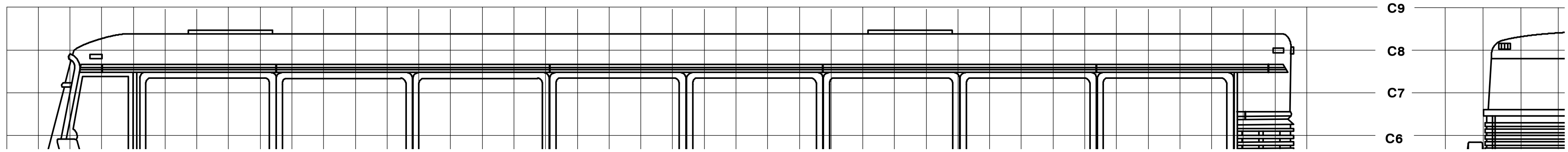
C1
B1 B2 B3 B4
A42 A41 A40 A39 A38 A37 A36 A35 A34 A33 A32 A31 A30 A29 A28 A27 A26 A25 A24 A23 A22 A21 A20 A19 A18 A17 A16 A15 A14 A13 A12 A11 A10 A9 A8 A7 A6 A5 A4 A3 A2 A1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C8
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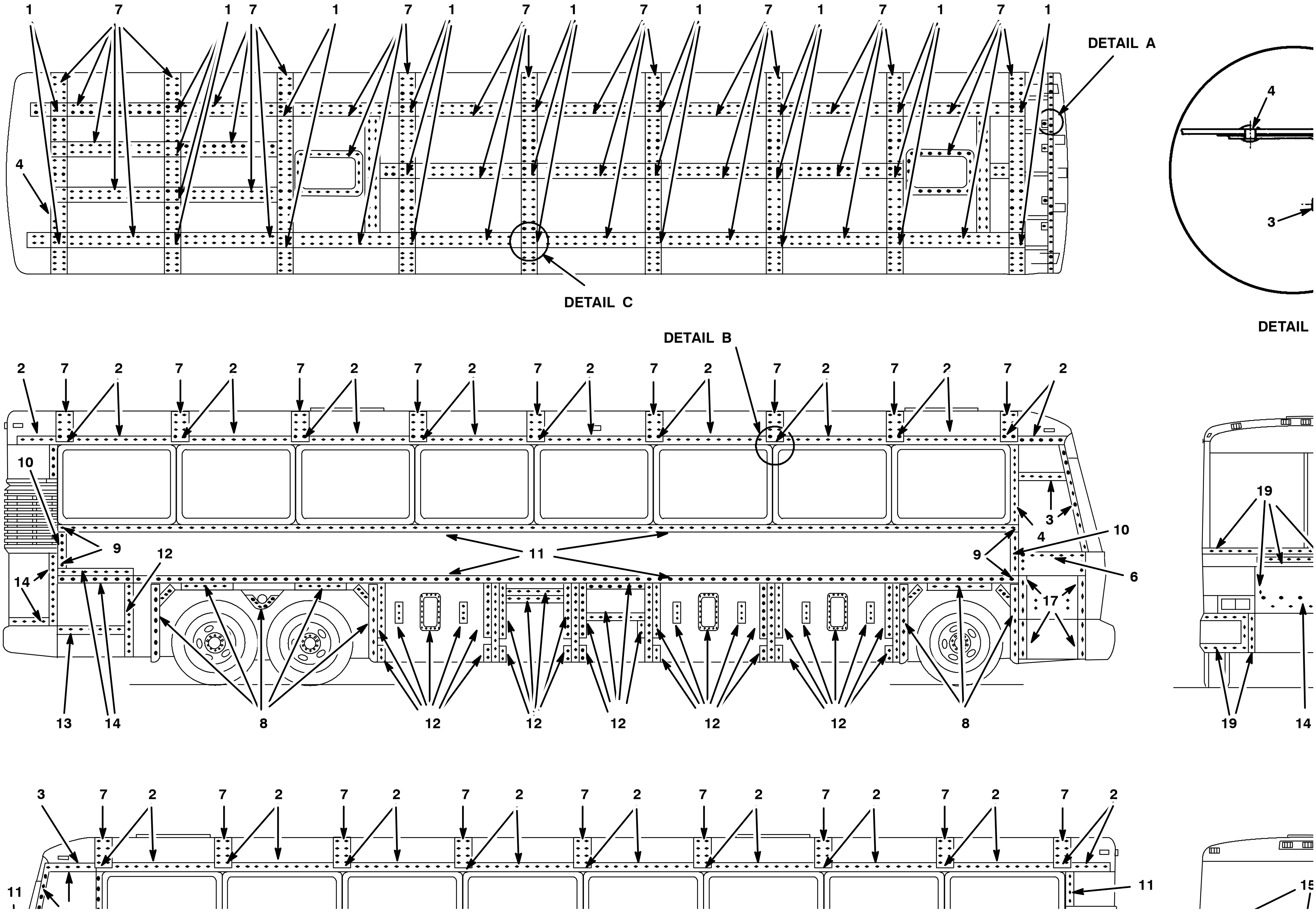
C6


DETAIL A
DETAIL C
DETAIL
DETAIL B

SECTION 3C2

WINDSHIELD WIPERS/WASHERS & EXTERIOR MIRRORS

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Windshield Wipers & Washers 3C2-1
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WINDSHIELD WIPERS & WASHERS

GENERAL DESCRIPTION

The 102D Series coaches utilize an air-operated windshield wiper/washer system to clean windshields during inclement weather conditions. This system features full arc pantograph-type wiper arms with large flexible wiper blades to provide a wide clean and safe viewing area for the driver. The two-speed wiper motors feature a "self parking" function as standard, and intermittent function with optional systems. These systems also include a large capacity washer reservoir.

Coaches may have either the standard heavy duty dry-type wiper system, or the electronically controlled (ECAM) intermittent wet-type system. Individual manual valves or electronic switches to control LH/RH wipers or washer functions are provided depending on the system installed. The air motors, wiper arms and washer reservoir all have serviceable parts which will be addressed in this section.

NOTE: Effective with unit 48093, the intermittent wiper system became basic on the D series coaches.

COMPONENTS

AIR MOTORS

The motor's internal rack gear transfers motion to the wiper arm shaft by various linkage arrangements. The motors incorporate either manual or solenoid-operated control valve bodies attached to the motor's body which connects to the air supply hoses.

The heavy-duty "Air Push II" series LH/RH air motors are position specific. They are mounted on brackets which attach to plates located directly behind the front cover panels.

WIPER ARMS

This 29-1/2 inch LH/RH pantograph-type wiper and idler arm assembly comes complete with large 26-inch (660.4-mm) wiper blades. Dry-type wiper arms will have stationary spray nozzles, while wet-type arms will have a spray nozzle attached to the connecting saddle. The wiper arms are connected to the motor's drive and idler shafts.

CONTROL VALVES

The standard (manual) system has individual LH/RH variable speed wiper control valves and a separate washer control valve that mount beneath the instrument panel (Figure 1). Control valves are provided with built-in air pressure regulators to assure constant wiper speeds during all pressure variations. Air hoses connect these valves to wiper motor control valve body and reservoir pump.

CONTROL SWITCHES

The intermittent (ECAM) system has individual LH/RH three-speed wiper and washer control switches that mount to the dash. LH/RH control switches feature separate “push-to-wash” function. The control switches are connected to the system solenoid valves by wire harness.

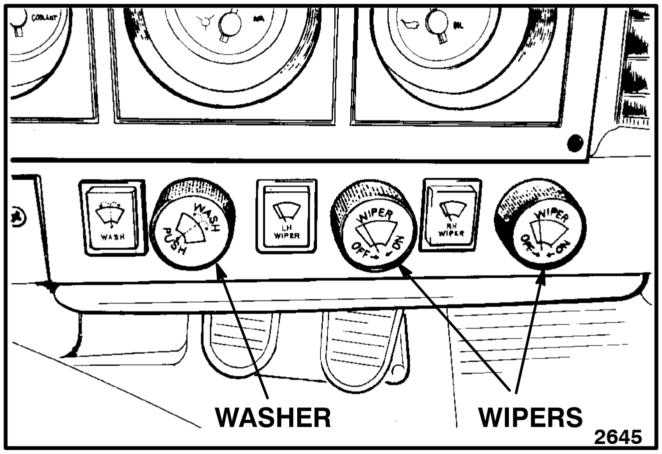


Figure 1. Windshield Washer and Wiper Knobs

NOTE: Integral air cushion solenoid valves, (on motor control valve body) are used to provide constant wiper speed during all pressure variations.

WASHER RESERVOIR

A 5 gallon washer reservoir (utilizing either single or dual air-operated diaphragm type pump), is used to deliver washer fluid to the spray nozzles (Figure 2). The windshield washer reservoir is located on the interior of the front LH side service door. The intermittent (ECAM) system uses two solenoid valves to control air pressure to the diaphragm pump. The reservoir’s pump is connected to the manual system’s control valve, and to the (ECAM) system solenoid valves.

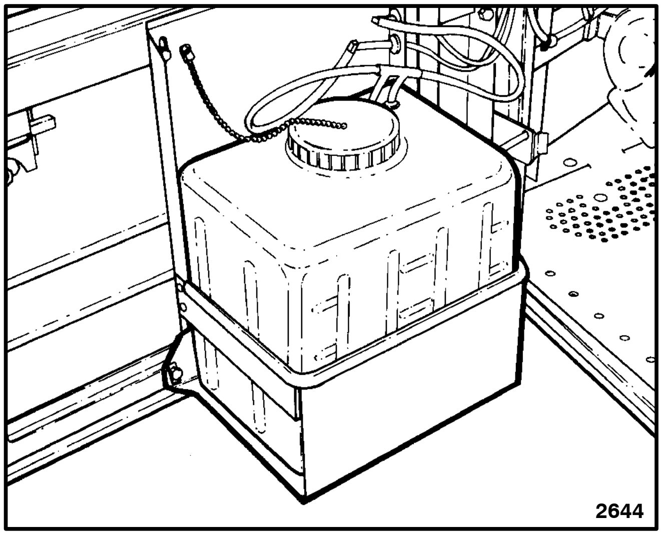


Figure 2 . Windshield Washer Solution Tank

OPERATION

AIR MOTOR

The air motors utilize a piston/rack arrangement to transfer piston’s lateral movement to a back-and-forth rotational motion when motors are in operation. The motor’s rack gear moves the transmission shaft and linkage lever in a primary sweep arc. This shaft interconnects by linkage arm to the wiper arm shaft, which is attached to the motor mounting bracket and produces the finished wiper sweep arc. The manual or solenoid valve body controls motor speeds and parking functions.

NOTE: Air motors require at least 85 psi air pressure in the accessory system to operate.

CONTROL VALVES & SWITCHES

To operate the manual wiper control valves, turn the LH or RH control knobs clockwise to desired speed. The variable-speed control should give approximately 50-53 cycles (sweeps) per minute (CPM) at full clockwise (high) position at rated air pressure. To stop wiper action turn knob counter-clockwise to “OFF” position.

To operate the two-speed three-position intermittent (ECAM) wipers control switch, turn the LH or RH control knob clockwise to first detent. This is the intermittent mode with variable-delay from 1 to 10 seconds between sweeps. Continue to next detent, which is low speed or continue to third position for high speed operation (approximately 50-53 CPM). Delay adjustments may be performed at the PDM module for the intermittent mode.

NOTE: Pressing in on either of the LH/RH wiper switches should begin the washer operation.

WASHER

To wash windshields the diaphragm pump inside the reservoir must be pressurized. This forces fluid out the delivery hoses to the spray nozzles. Lines are purged automatically before and after each spray cycle, eliminating freezing or clogging of lines and nozzles. The system spray nozzles are completely adjustable.

To operate manual windshield washer systems, press in on control knob and hold in this position. The washers will spray for a short period of time until the pump diaphragm bottoms out, and then the control knob must be released to allow diaphragm to recover. Release knob for approximately 30 seconds before operating washers again to allow pump to sufficiently refill. With the manual system the LH/RH wipers must be turned on when washers are optioned. Washers continue to spray until pump is empty.

Intermittent (ECAM) system automatically turns LH or RH wiper on to slow speed when either of the control switch knobs are pushed. Washers should spray approximately 5 seconds and then shut off. Wipers should continue to sweep for approximately 5 to 6 cycles after washers stop spraying. With the intermittent system the solenoid valves release a specific amount of air pressure to the diaphragm and then shut off.

MAINTENANCE

CLEANING & LUBRICATION

Wiper motor control valves require no periodic maintenance between overhaul. At overhaul the windshield wiper motors and wipers should be disassembled, cleaned and lubricated. We recommend using Sprague Wiper Lube P/N Y-143 or Y-217. The following guidelines are to be used on new or rebuilt wiper motors to increase service life.

A. One of the best preventive actions is to avoid letting the wiper system sit too long without operation. Wiper systems should run every other day, if only for a few cycles. This action will keep the lubricant flowing and O-rings supple.

B. If the system has seen heavy usage, it is recommended that new O-rings and fresh lubricant be installed at regular intervals. If O-rings are not damaged and the motor is not frozen, lubricant injected into the air lines will keep a motor running properly.

We recommend that a small amount be injected into each motor at a location as close to the motor valve body as possible. Allow motor to run 15 minutes to evenly lubricate all parts. Lubricating in this manner every six months is sufficient. Where heavy contamination is present, more frequent applications may be required. Do not use any type of penetrating fluid or oil.

C. Every 100,000 miles (161,000 km), the air strainers and filters should be disassembled and cleaned.

D. In-line oilers will act as an air filter as well as keep a supply of oil going to the wiper system. These should have a drain and oil change at least twice a year.

E. Alcohol injectors are very useful for vehicles operating in severe cold conditions, however, precautions should be taken to keep sufficient lubricant in the motors at all times.

REPLACEMENT

Before removing any components from the coach, perform the following:

1. Assure that the LH/RH motors are in full park position.
2. Turn the main battery disconnect switch to “OFF”.
3. Vent all air pressure from the system.

AIR MOTOR

The motor consists of five sub-assemblies: mounting bracket assembly (with drive linkage), motor body (in halves), control valve body, piston/rack assembly and rack gear (Figure 3) Follow these procedures to remove, disassemble and reinstall the wiper motor.

1. Remove windshield wiper arms and blade assembly from motor wiper and idler shafts. Disconnect any wet wiper washer hose lines.
2. Remove spanner nut retaining wiper shaft spacer.
3. Unfasten and remove the fascia cover panel.
4. Unfasten and remove wiper motor mounting plate and lift out the complete assembly. Disconnect all air hoses to the motor.
5. Unfasten plate from the wiper motor mounting bracket. At this point the wiper motor assemblies are serviceable, however, if further disassembly is required, continue with the following steps.
6. Unfasten the wiper motor mounting bracket from motor body. Rotate motor body to allow transmission shaft to disengage from rack gear inside motor and remove.

NOTE: A hex locknut may be used to attach lever to transmission shaft.

7. Remove the screws holding the body halves together. Separate the halves, noting the position of motor valve body location and position of timing marks on gear and rack.
8. Remove the shaft, gear and sleeve assembly, if applicable.

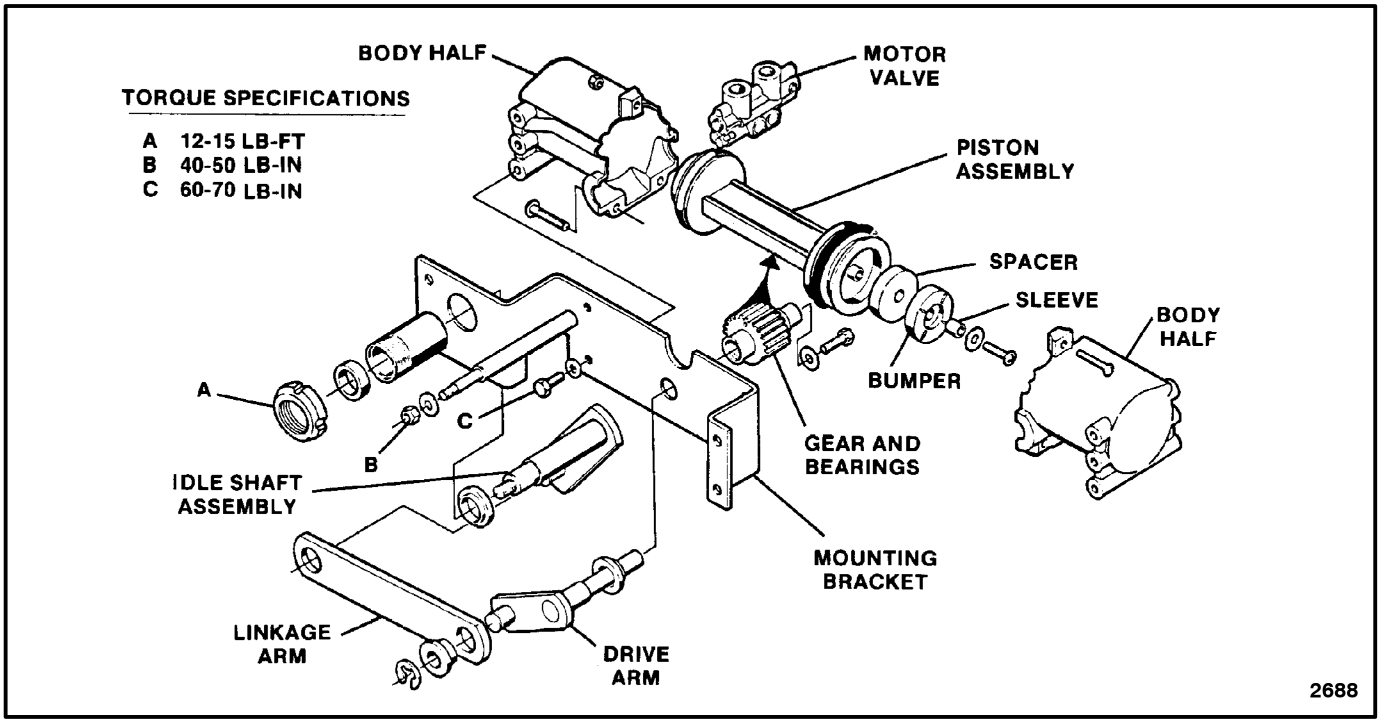


Figure 3. Windshield Wiper Motor

9. Remove the control valve body from motor half.

A. No further disassembly is required on manual systems. Replace if necessary with proper valve body.

B. The solenoid assemblies (run/park port) of the intermittent (ECAM) system can be serviced using special tool included in service kit #53 from Sprague.

10. Remove the piston/rack assembly from body halves. Remove O-rings, rubber bumpers and spacers and replace as needed.

11. Remove the shaft and rack gear assembly Remove shaft and bearings and inspect. Replace if gear has excessive wear.

12. Clean all metal parts with an approved solvent, and blow all air passages clear. Inspect all internal parts for excessive wear and replace when necessary. Check interior of both body halves for excessive scoring.

13. Lubricate parts with Sprague grease as noted previously and reassemble the sub-assemblies in reverse order.

NOTE: It is recommended that O-rings and valve body seals be replaced when reassembling.

14. Bubble test the assembled motor for air leakage and carefully tighten fasteners where necessary.

15. Reassemble motor onto mount bracket and plate in reverse order, and reinstall in its proper location in reverse order.

MANUAL CONTROL VALVE

Individual wiper/washer control valves can be removed from the vehicle for cleaning or repair if necessary.

1. Tag and disconnect all air hoses to the control valve.
2. Remove the valve's knob to expose retaining nut.
3. Unfasten nut and remove the valve from the dash panel.
4. Clean all metal parts with an approved solvent, and blow all air passages clear. Inspect all O-rings and replace when necessary. Check interior of valve body for excessive scoring.
5. Reassemble and reinstall in reverse order.

INTERMITTENT (ECAM) CONTROL SWITCH

1. Disconnect solenoid wire harnesses from LH/RH switch module.
2. Remove the valve's knob to expose retaining nut.
3. Unfasten nut and remove the valve from the dash panel.

NOTE: The switch and PWM control module are serviced as an assembly, however, the control switches may be available for purchase separately.

WINDSHIELD WIPER ARM & BLADE

The pantograph-type wiper arm assembly consists of four sub-assemblies: wiper arm (driven), idler arm, saddle link and wiper blade (Figure 4).

Wiper Arms

1. Disconnect washer fluid hoses from wet wiper assemblies.

2. Unfasten and remove the saddle mounting hardware from either the wiper or idler arm to be replaced.

3. Unfasten acorn nut, and remove head clamp bolt from wiper arm. Gently pry head off serrated output shaft.

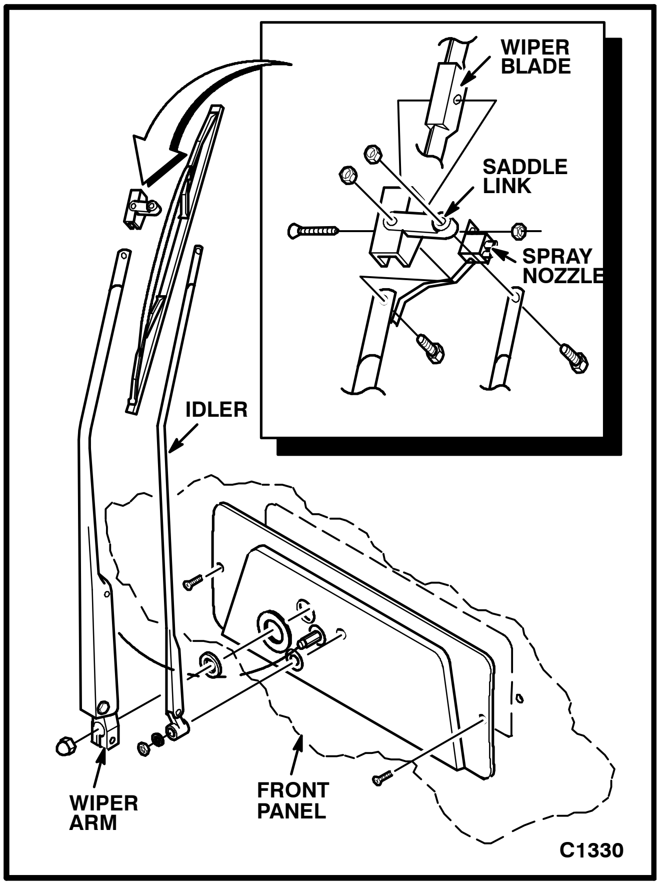


Figure 4. Windshield Wiper Arm Assembly

4. Unfasten hex locknut and lockwasher of idler arm, and gently pry head off idler shaft.

5. Reinstall the new arm in reverse order as required. During reassembly attache the saddle to the main wiper arm first, and then to the idler arm.

Element (Blade Rubber)

1. Lubricate each end of the wiper blade with soap solution.

2. With small pliers, flatten the bent-up feet of the retaining clip at each end of wiper blade.

3. Gently squeeze feet together to slide clip out and off of wiper blade guides.

4. Gently slide the old element out of guides and off one end of blade.

5. Replace element in reverse order and bend up feet with flat blade tool.

Wiper Blade

1. Unfasten and remove the wiper blade mounting screw to remove blade assembly from saddle.

2. Reinstall the new blade in reverse order as required. Be sure blade is assembled in the saddle correctly before tightening mounting/retaining screws.

NOTE: The saddle assembly incorporates an internal bushing. Blade should have free movement in the saddle; do not crush saddle over blade assembly.

3. Test the wiper arm and blade action through operation of wiper system.

NOTE: Wiper pattern should be centered and tips of wiper blades not touching rubber moldings. If the sweep is off center it will be necessary to adjust main arm to center the sweep.

WINDSHIELD WASHER

Reservoir

1. At top of reservoir, tag and disconnect all air/fluid hoses from the diaphragm pump(s) to the control valve or dual solenoid valves (ECAM system).

2. Unfasten and remove reservoir cap and remove bottle from coach.

NOTE: The side brackets may need to be unfastened before bottle can be removed.

Pump

1. At top of reservoir, tag and disconnect all air/fluid hoses from the diaphragm pump(s) to the control valve or dual solenoid valves (ECAM system).

2. Open reservoir cap and remove diaphragm pump assembly(s) through opening.

3. Reinstall in reverse order and reconnect tubing.

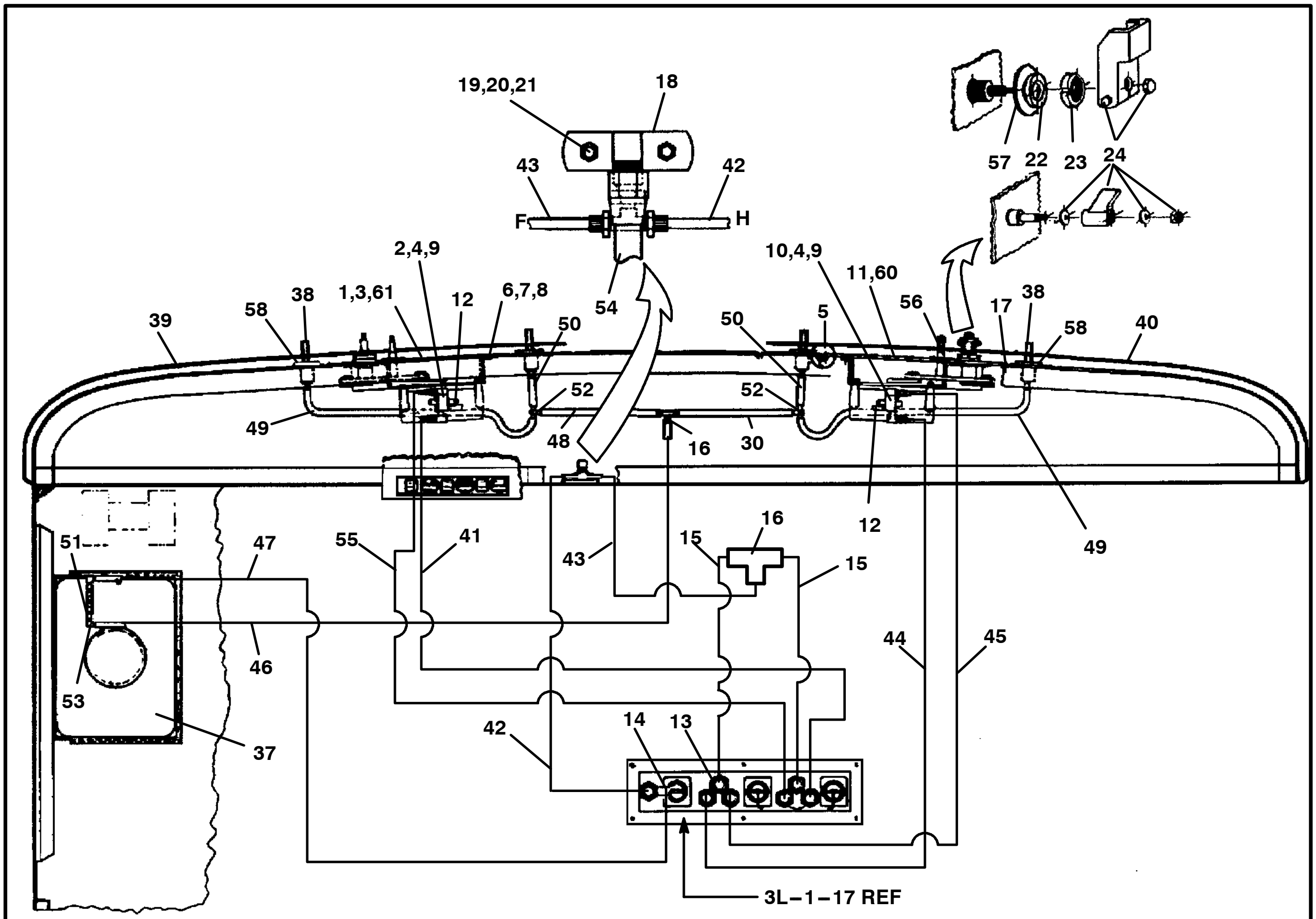
Solenoid Valves (ECAM)

1. Tag and disconnect all air hoses and wire harnesses from the valves.

2. Unfasten and remove the solenoid valve from the coach.

TUBING & HOSES

The wiper/washer air/fluid tubing and hoses should be routinely inspected for leakage and serviceability. Replace old tubing and hoses with same diameter to maintain proper performance. Refer to the basic wiper/washer tubing/hose connections list (Figure 5).



1. PLATE, W/S WIPER MOTOR MOUNT
2. MOTOR AND BRACKET ASSY – LH
3. PLATE S/A, MOUNTING – LH
4. TYRAP
5. SCREW, MACHINE (1/4–20 x 3/4 UNC FH CR)
6. CAPSCREW (1/4–20 x 1/2 UNC HX)
7. NUT (1/4–20 UNC)
8. LOCKWASHER (1/4)
9. INSULATION
10. MOTOR AND BRACKET ASSY – RH
11. PLATE,W/S WIPER – RH
12. TUBING – EXHAUST (BLACK)
13. VALVE ASSY, CONTROL
14. VALVE ASSY, WASHER CONTROL
15. TUBING – VALVE JUMPER (GREEN)
16. TEE, MALE (1/4 TUBE)
17. SEAL
18. ELBOW, ANCHOR
19. CAPSCREW (1/4–28 x 1 UNF)
20. NUT (1/4–28 UNF)
21. LOCKWASHER (1/4)
22. WASHER SPACER
23. NUT, SPANNER
24. ARM, PANTOGRAPH
37. BOTTLE RESERVOIR ASSY.
38. NOZZLE
39. FASCIA S/A – LH
40. FASCIA S/A – RH
41. TUBING – LH MOTOR TO VALVE (BLUE)
42. TUBING – ANCHOR ELBOW, SHORT (WHITE)
43. TUBING – ANCHOR ELBOW, LONG (BLACK)
44. TUBING – RH MOTOR TO VALVE, SHORT (NYLON RED) (BLUE)
45. TUBING – RH MOTOR TO VALVE, LONG (NYLON RED)
46. TUBING – RESERVOIR TO NOZZLE MN (ORANGE)
47. TUBING – RESERVOIR TO VALVE (WHITE)
48. TUBING – RESERVOIR MN LH, RH (ORANGE)
49. HOSE – NOZZLE OUTBOARD
50. HOSE – NOZZLE INBOARD LH, RH
51. HOSE – RESERVOIR SPLICE
52. TEE, HOSE
53. ELBOW 90° (1/4 TUBE)
54. HOSE – MAIN AIR FEED
55. TUBING (RED)
56. PLUG (96A2/A3 & 102A2/A3/AW3 ONLY)
57. SEAL S/A (102C3 ONLY)
58. SEAL S/A, WASHER (102C3 ONLY)
60. COVER, W/S WIPER MOTOR MTG, RH
61. COVER, W/S WIPER MOTOR MTG, LH

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Figure 5. Basic Wiper/Washer Tubing Connections and Parts Locations

WIPER TROUBLESHOOTING - MANUAL SYSTEM

SYMPTOM	PROBABLE CAUSE	REMEDY
1. MOTOR WILL NOT OPERATE	A. Inadequate air supply to motor.	A. Check the air compressor operation and air lines leading to the control valve for contamination, breakage or leaks.
	B. Defective control valve.	B. Check the control valve knob for sticky conditions, or check intake and feeder ports for blocked operations. Also check O–rings in control valve for leaks, and air lines leading from the control valve to motor for air leaks, contamination or breaks.
	C. Defective motor valve.	C. Check the primary and secondary valve rods to see if they are binding in the chambers. Check for defective O–rings on the rods.
	D. Clogged air passages in motor.	D. Disassemble the motor and clear air passages.
	E. Linkage locked up.	E. Check that transmission shaft has been properly inserted. Also check drive pin for excess wear and proper lubrication. Check to see if linkage is hitting against the coach window side. This may be due to improper size drive bar or pin, pulling linkage out of proper line of travel.
	F. Motor is getting air, but shaft is not turning.	F. Check all drive components for broken valve pin, gear or rack. Also examine gear and rack for excessive wear which may be making improper gear engagement. If a tapered shaft is used, check to see if it has broken loose from the gear.
2. MOTOR OPERATES BUT WIPER DOES NOT MOVE	A. Shaft is operating but arm does not move.	A. Check if arm driver is cracked, or has become disengaged through wear or some other cause.
3. MOTOR OPERATES AT LESS THAN FULL POWER	A. Air leak in the Control Valve.	A. Check O–rings for wear or flat spots.
	B. Air leak in the wiper motor.	B. Examine the large O–rings on piston rack for wear or flat spots. Also examine the cylinder walls of the motor to see if they are scored.
4. MOTOR OPERATES IN AN ERRATIC MANNER	A. Reverser “T” drilled off center, not drilled deep enough, or it may hang up on reverser rod.	A. Disassemble motor and examine reverser “T”. If “T” is hanging up on rod, lubricate and examine bore for flash. Examine rod for sludge deposit which could cause “T” to stick.

WIPER TROUBLESHOOTING - MANUAL SYSTEM (Contd.)

SYMPTOM	PROBABLE CAUSE	REMEDY
4. MOTOR OPERATES IN AN ERRATIC MANNER	B. O–rings fit too tightly in bore of motor valve.	B. Disassemble motor valve by removing the end plates. Examine primary and secondary valve rods to see if any O–rings show a high spot or complete oversize.
	C. O–rings too tight in main cylinder bore.	C. Examine large O–rings on piston assembly for high spots or complete oversize. Also, examine cylinder wall bore to see if there is dirt or sludge on which piston may be sticking.
	D. Exhaust ports plugged.	D. Examine ports to see if plugged or blocked. Clean and clear them to allow free escape of air from motor.
	E. Unused parking end plate plugged.	E. If motor valve has parking end plate on both ends, check to see that the unused park end plate is not plugged.
5. SLAMMING ACTION BY ARM ON ONE SIDE OF SWEEP	A. Loss of pressure at one end of cylinder, causing no back pressure on returning swing of motor.	A. Replacement of main O–ring. Clean port to allow air passage to maintain proper air pressure in cylinder. Examine O–rings on primary and secondary rods and replace if worn.
6. MOTOR SWEEPS “SHORT” IN ONE DIRECTION	A. Reverser “T” drilled off center.	A. Disassemble motor and examine reverser “T” on reverser rod. Hole for valve pin must be drilled on center.
	B. Defective primary valve rod.	B. Remove primary valve rod from motor valve and see if the rod is sticking due to sludge or residue in cylinder bore. Clean bore and lubricate. Check and replace improperly sized or worn O–rings.
	C. Defective cylinder or cylinder O–ring.	C. Disassemble motor and examine large O–rings on piston rack for wear. Examine cylinder wall for sludge which would cause piston to stick or stop short of full travel. Check cylinder wall for defects or cracks which could stop the piston travel.
7. MOTOR OVERSWEEPS (OFF THE GLASS)	A. Worn transmission gear rack in motor.	A. Disassemble motor and check gear and rack for wear. Replace worn parts.
	B. Piston stops worn or broken.	B. Examine piston rack to see if piston stops on the reverse rod are still the proper length. Replace as necessary.
	C. Worn arm pivot points, causing arm to slip on shaft when shaft stops.	C. Examine the shaft for gear slippage. If not, see if arm driver is worn or broken. If so, replace arm or arm driver.

WASHERS TROUBLESHOOTING - MANUAL SYSTEM

SYMPTOM	PROBABLE CAUSE	REMEDY
1. FAILS TO EMIT WASHER SOLUTION	A. Reservoir empty.	A. Add proper fluid.
	B. If below 32°F (0°C) improper washer fluid–frozen.	B. Store coach or parts in heated area. Then purge system with low–temperature solution.
	C. Contamination in tubing or nozzles.	C. Remove with compressed air. If severely clogged, replace items.
	D. Tubing damage.	D. Replace section.
	E. Tubing bent (kinked) or off one or more connections.	E. Realign tubing and/or refit. Trim end to ensure proper fit or replace.
2. CONTROL VALVE FAILS TO OPERATE	A. Coach air system low.	A. Establish a minimum of 90 psi (621 kPa).
	B. Coach air pressure inadequate – air to valve below 90 psi (621 kPa).	B. Check lines for kinks.
	C. Air pressure from valve outlet below 35 psi (241 kPa).	C. If air pressure to valve is correct, check for clogged inlet port. If clear, replace valve.
3. CONTROL VALVE OPERATIVE BUT SYSTEM INOPERATIVE	A. Diaphragm damaged.	A. Replace valve.
4. INADEQUATE EXPULSION OF WASHER SOLUTION	A. Tubing failure.	A. Replace tubing.
5. AIR LINES BLOWING	A. Damaged tubing.	A. Replace tubing.
6. SLOW OPERATION	A. Inadequate air pressure.	A. Check air system.
	B. Improper solution.	B. Replace with proper type solution.
	C. Jet stream improperly directed.	C. Reposition nozzles.
7. DIAPHRAGM DOESN'T REFILL	A. Faulty diaphragm.	A. Replace diaphragm.
	B. Faulty control valve.	B. Replace control valve.
	C. Valve assembly atop the reservoir is stuck in the open position.	C. Remove, clean and lubricate or replace.

WIPER TROUBLESHOOTING - INTERMITTENT SYSTEM

GENERAL DEFECTS

SYMPTOM	PROBABLE CAUSE	REMEDY
1. BOTH LEFT AND RIGHT SYSTEMS ARE INOPERATIVE.	A. No air pressure to system.	A. Check for proper air supply.
	B. No electrical power supply system.	B. Check fuses and check breaks in the electrical wiring.
2. ONLY ONE (1) SYSTEM IS INOPERATIVE.	A. No air pressure to that system.	A. Check for proper air supply to that system.
	B. No electrical power to that system.	B. Check fuse, and if OK, check electrical connectors for proper mating.

DEFECTS RELATED TO THE DASH CONTROL

SYMPTOM	PROBABLE CAUSE	REMEDY
1. CONTROL DOES NOT “FEEL RIGHT”.	A. Counterclockwise park detent, center “low” speed detent or clockwise “high” speed detent missing or not pronounced.	A. Replace dash switch.
	B. Control rotates a full 360 degrees.	B. Replace dash switch.
2. NO SYSTEM OPERATION OR ONE OR MORE FUNCTIONS OF THE SYSTEM MISSING, INOPERATIVE OR NOT CORRECT.	A. Low speed does not occur at the center detent of rotation.	A. Replace dash switch.
	B. No “click” or spring return of the wash function (Note: Check knob installation on shaft for proper depth to allow for full push switch travel).	B. Replace dash switch.
3. WILL NOT PARK AT “OFF” POSITION.	A. Defective switch assembly.	A. Replace dash switch.
4. NO WIPER SYSTEM SPEED CHANGE FROM “LOW” TO “HIGH”.	A. Defective potentiometer assembly.	A. Replace dash switch.
5. NO INTERWIPE DELAY TIME CHANGE WHEN ROTATED FROM LONG TO SHORT.	A. Defective potentiometer assembly.	A. Replace dash switch.

DEFECTS RELATED TO THE MODULE

SYMPTOM	PROBABLE CAUSE	REMEDY
1. IMMEDIATE OR FREQUENT FUSE BLOWING.	A. Defective module.	A. Replace module.
2. NO SYSTEM OPERATION AND SWITCH, AIR MOTOR, ELECTRICAL CONNECTORS AND AIR SUPPLY CHECK OUT.	A. Defective module.	A. Replace module.

WIPER TROUBLESHOOTING - INTERMITTENT SYSTEM (CONTD.)

DEFECTS RELATED TO THE MODULE (CONTD.)

SYMPTOM	PROBABLE CAUSE	REMEDY
3. NO ELECTRICAL OUTPUT TO “PARK” SOLENOID.	A. Defective module.	A. Replace module.
4. NO ELECTRICAL OUTPUT TO “RUN” SOLENOID.	A. Defective module.	A. Replace module.
5. NO ELECTRICAL OUTPUT TO WASHER SOLENOID VALVE.	A. Defective module.	A. Replace module.
6. “PARK”, “RUN” OR “WASH” SOLENOID COILS ARE WARM OR HOT AND STUCK “ON” OR OPEN.	A. Short output FET in module.	A. Replace module.
7. INCORRECT “LOW” SPEED WIPER CYCLES PER MINUTE.	A. Module “low” speed PWM duty cycle output is the wrong percentage.	A. Replace module.
8. MOTOR “PARKS” AND THEN CONTINUES TO RUN IN “HIGH” SPEED WHEN THE DASH CONTROL IS TURNED TO THE “OFF” POSITION	A. Shorted output FET in module.	A. Replace module.
9. MOTOR STOPS IN A POSITION OTHER THAN “PARK” WHEN THE DASH CONTROL IS TURNED TO THE “OFF” POSITION.	A. Defective motor solenoid valve.	A. Replace motor.
10. EXHAUST AIR IS MOMENTARILY HEARD FROM THE MOTOR WHEN THE DASH CONTROL IS TURNED TO ANY POSITION WITH LITTLE OR NO MOTOR MOVEMENT.	A. Open output FET in module.	A. Replace module.
	B. Defective motor solenoid valve.	B. Replace motor.

DEFECTS RELATED TO THE AIR MOTOR

SYMPTOM	PROBABLE CAUSE	REMEDY
1. MOTOR DOES NOT EXHIBIT PROPER “HIGH” SPEED CPM. IS EITHER TOO HIGH OR TOO LOW; EXPERIENCES LOPING OR GENERALLY DOES NOT “RUN RIGHT”.	A. Obstruction in the air line feeding the motor.	A. Remove the obstruction.
	B. Foreign material in the motor run solenoid valve (or solenoid damaged).	B. Replace the motor.
	C. Air motor exhaust restrictor is not set, or is not operating properly.	C. Replace motor.
	D. Motor “park” or “run” solenoid valve restrictor orifice problem.	D. Replace motor.

WIPER TROUBLESHOOTING - INTERMITTENT SYSTEM (CONTD.)

DEFECTS RELATED TO THE AIR MOTOR (CONTD.)

SYMPTOM	PROBABLE CAUSE	REMEDY
2. MOTOR LEAKS AIR.	A. Motor valve body leaks at body seal gasket. Bad casting or cut o-ring.	A. Replace motor.
	B. With motor in “off” position, solenoid valves leak around the valve bases. *Note: During motor operation, while solenoids are energized, normal air leakage may be noted at motor and solenoid thread bases.*	B. Replace motor (first check to see if the valves are screwed tightly into the casting.)
	C. Air line at motor leaks.	C. Repair or replace air line or fitting.
3. EXCESSIVE NOISE FROM THE MOTOR INSTALLATION.	A. Damaged or missing exhaust tubing.	A. Replace damaged or missing tubing.
	B. Improperly piped exhaust tubing.	B. Check to see that the tubing installation matches both the print from the motor exhaust and the barb fittings from the top of both the park and run solenoid valves.
4. NO “PARK”, OR ANY “RUN” MODE WHEN THE SIGNAL IS PRESENT AT THE MOTOR ELECTRICAL CONNECTORS.	A. Jammed or defective motor solenoid valves(s). Plunger guide bent.	A. Replace motor.

DEFECTS RELATED TO THE WASHER SYSTEM

SYMPTOM	PROBABLE CAUSE	REMEDY
1. WASHER SYSTEM INOPERATIVE.	A. No air supply to the washer regulator valve.	A. Correct air supply problem.
	B. Washer regulator valve does not function when a wash cycle is called for by pressing the control knob down.	B. Check for the proper mating of the electrical connector to the valve coil.
	C. No washer solvent in reservoir.	C. Fill the reservoir with washer solvent.
2. HOSE BLOWING OFF THE WASHER REGULATOR VALVE OR THE WASHER DIAPHRAGM UNIT.	A. Plugged tubing.	A. Correct the obstruction.
	B. Defective muffler on the washer regulator valve assembly.	B. Replace washer regulator valve.
	C. Defective valve assembly.	C. Replace washer regulator valve.
3. WASHER DIAPHRAGM UNIT RUPTURES.	A. Defective valve assembly.	A. Replace washer regulator valve.
4. WASHER REGULATOR VALVE STOCK “ON”.	A. Indicative of a defective control module if disconnecting the electrical connector clears the problem.	A. Replace module.

WIPER TROUBLESHOOTING - INTERMITTENT SYSTEM (CONTD.)

DEFECTS RELATED TO THE WASHER SYSTEM (CONTD.)

SYMPTOM	PROBABLE CAUSE	REMEDY
4. WASHER REGULATOR VALVE STOCK "ON".	B. Indicative of a defective washer regulator valve if disconnecting the electrical connector does not clear the problem.	B. Replace washer regulator valve.

SPECIFICATIONS

MOTOR & BRACKET ASSEMBLY

Manufacturer	Sprague Devices
Part Number (Prior To Unit #48093)	3J-34-51 (LH) 3J-34-52 (RH)
Part Number (Effective with Unit #48093)	3L-34-1344 (LH) 3L-34-1345 (RH)

PANTOGRAPH ARM ASSEMBLY

Manufacturer	Sprague Devices
Part Number (Dry Type)	3J-34-3
Part Number (Wet Type – ECAM)	3K-34-2

RESERVOIR & PUMP ASSEMBLY

Manufacturer	Sprague Devices
Part Number (Dry Type)	3J-34-8
Part Number (Wet Type – ECAM)	3J-34-74

EXTERIOR MIRRORS

GENERAL DESCRIPTION

Manually adjusted Ramco exterior rear view mirror assemblies are installed as basic equipment on the coaches. Optional heated and remote controlled mirrors are also available in painted or anodized finishes. These mirrors have serviceable convex and flat glass units.

NOTE: Effective with unit 47178 a new Ramco mirror assembly with convex mirror heads mounted on top of the flat mirror head was introduced. These mirrors have either a 10 inch (5500 series), or 13 inch (6000 series) lower full face mirror head.

COMPONENTS

MIRRORS

Three basic components of the mirror assemblies are the mirror head(s) with ball stem mounts, mirror support arm with ball cup, and coach mounting brackets. The mirror heads are attached by setscrews to the pivoting support arms (Figure 6). The support arms are mounted to the mounting bracket with capscrews. Most arms are milled with internal stops to prevent glass damage when rotated inward. The brackets are mounted to the LH/RH A-posts with screws.

SWITCHES

The mirror heat switch is located on the LH upper switch panel. Once energized the mirror heating element is kept at a sustained temperature by a heat regulated disc thermostat. The remote adjustment control joystick for the mirrors is mounted on the lower LH switch panels, or in combination with the RH lower instrument panel mount location. A wiring diagram can be found in Section 7J of this manual.

MAINTENANCE

SWITCHES

Heat Control Replacement

1. Turn battery disconnect switch to "OFF" position.
2. Unfasten and remove switch panel and gently squeeze retaining clip to remove switch.

Joy-Stick Control Replacement

1. Turn battery disconnect switch to "OFF" position.

2. Reach behind instrument panel and gently squeeze retaining clip to remove control.

NOTE: Remove panel first if joy-stick control is mounted to the lower LH switch panel(s).

3. Disconnect harness and replace with new control.

MIRRORS

Adjustments

For fine adjustments, the basic mirrors glass units can be pivoted via plastic housings located inside the head. On remote controlled units, the flat glass has a mirror motor that controls fine adjustments. Mirror position is changed when the controller's arrow is turned to point to the driver's or entrance door mirror and is actuated causing the mirror glass to move accordingly. The remote motor mounts to the mirror head behind the mirror glass.

NOTE: Some mirror assemblies may have the convex glass remotely fine adjusted by way of an additional joystick.

A capscrew and Belleville washer holds the support arm to the A-post mounting bracket. This support arm capscrew can be loosened to position the mirror head into or away from the coach body. An upper and lower setscrew fastens the mirror heat to arm. Follow these steps to make the initial adjustments to the mirror assemblies.

1. Loosen the capscrew at the base of the mirror arm to swing the mirror arm in or out as desired. Retighten to approximately 25 ft-lbs torque.

NOTE: A pin in the top of the mirror arm base and a groove in the mirror arm limits the movement of the arm and prevents the mirror head from contacting the driver's window or the windshield.

2. Loosening the upper and lower setscrews allows the whole head assembly to turn in the support arm for this adjustment.

Mirror Glass Replacement (Unheated)

Mirror glass units are Velcro fastened to the aluminum mirror plate. A dot of silicone sealant is also applied to the top and bottom of the glass/plate assembly.

1. Remove all broken glass from plate. To remove an unbroken glass, adjust mirror to allow top or bottom edge to move out away from head casting and gently pry Velcro fastener apart.

2. Clean the aluminum plate and apply 1/4" dot of silicone sealant to top and bottom of plate.

3. Position new glass in place and press the Velcro fastener securely together.

Mirror Glass Replacement (Heated)

1. Turn battery disconnect switch to "OFF" position.

2. Remove all broken glass from plate. To remove an unbroken glass, adjust mirror to allow top or bottom edge to move out away from head casting and gently pry Velcro fasteners apart.

3. Disconnect heating element pigtails from main connector.

4. Connect new heated mirror glass unit pigtail connectors, and reinstall the aluminum plate.

5. Follow steps 2 and 3 of the previous "Replacement" procedure.

Removal

1. Turn battery disconnect switch to "OFF" position.

2. Unfasten and remove the four screws fastening the support bracket to the coach.

3. Disconnect any electrical harnesses at the mount bracket.

Disassembly (Old Style)

1. Unfasten capscrew and Belleville washer at arm base and remove the mounting bracket from arm and mirror head assembly.

2. Loosen the upper and lower setscrews at mirror arm end to relieve tension on the ball stud. Remove mirror head by pulling the ball stud from the arm's ball cup halves.

Disassembly (New Style)

NOTE: Effective with unit 47178 a new style Ramco mirror assemblies with convex mirror head mounted on top of the flat mirror head were introduced.

1. Follow steps 1 and 2 of the previous "Disassembly" procedure.

2. Adjust mirror to allow top or bottom edge to move out away from head casting and gently pry Velcro fastener apart and remove the flat mirror glass unit from the lower head assembly.

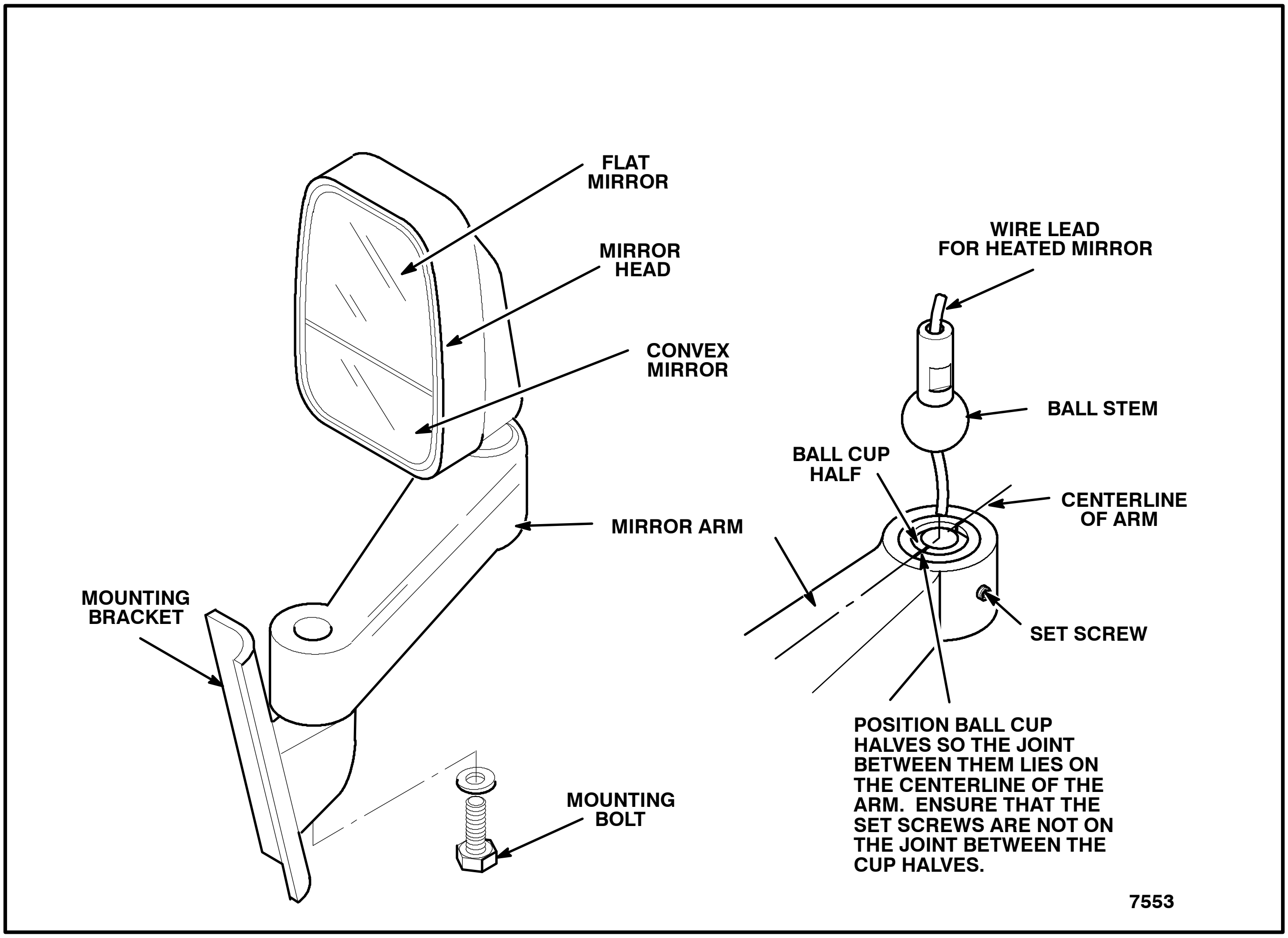
FLAT MIRROR
MIRROR HEAD
CONVEX MIRROR
MIRROR ARM
MOUNTING BRACKET
MOUNTING BOLT
WIRE LEAD FOR HEATED MIRROR
BALL STEM
BALL CUP HALF
CENTERLINE OF ARM
SET SCREW
POSITION BALL CUP HALVES SO THE JOINT BETWEEN THEM LIES ON THE CENTERLINE OF THE ARM. ENSURE THAT THE SET SCREWS ARE NOT ON THE JOINT BETWEEN THE CUP HALVES.
7553

Figure 6. Mirror Heat Switch and Remote Control Switch.

3. Remove aluminum plate from manual or motor adjust mechanisms by unfastening the four (4) screws. Remote controlled plates have an additional three (3) screws.

4. Unfasten and remove the two screws that secure the upper mirror head to the lower head. The convex mirror head may now be removed.

> **NOTE:** On heated convex mirror units the flat mirror head aluminum plate must be remover to gain access to the heater element's pigtail wires for removal from connector.

Assembly

1. Reassemble in reverse order of the "Disassembly" procedure. Snake all new harness wires through head joints and insert the wire into their respective connectors.

2. Reconnect the mirror head harness connectors

3. Insert the ball stud into the mirror arm's cups and tighten the socket setscrews.

> **NOTE:** Position the ball cup halves so the joint between them lies on the centerline of the arm. Ensure that the setscrews are not on the joint between the cup halves.

Installation

1. Reinstall in reverse order of the "Removal" procedure.

SPECIFICATIONS

EXTERIOR MIRROR ASSEMBLY

Manufacturer	Ramco
Part Number (Effective with Unit #47178)	3L-22-333 (LH) 3L-22-334 (RH)

SECTION 3D1

ENTRANCE DOORS AND RETRACTABLE STEP

CONTENTS OF THIS SECTION

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Sedan Door 3D1-1
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  Components 3D1-1
  Operation 3D1-2
  Maintenance 3D1-4
Bi-parting Entrance Door 3D1-16
  General Description 3D1-16
  Components 3D1-16
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Retractable Entrance Step 3D1-22
  General Description 3D1-22
  Components 3D1-22
  Operation 3D1-22
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Specifications 3D1-26
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SEDAN DOOR

GENERAL DESCRIPTION

An air operated sedan style entrance door is installed as basic on the D series coaches. When opened, a clear door opening of 30 x $84\frac{5}{8}$ inches (760 x 2150 mm) is attained. The door is operated by a control assembly located under the stepwell, and a combination air/hydraulic cylinder assembly installed under the right-hand dash. The door is hinged at the bottom front and at the dash level. A glass upper sash and clear plastic lower window are installed on the door. Door actuation switches are located on the driver's RH switch panel and in the exterior switch pocket adjacent to the door.

NOTE: RV door installed on conversion coaches do not have the lower window.

COMPONENTS

DOOR ASSEMBLY

The sedan door features an all welded stainless steel frame. Painted aluminum outer skin and fiberglass inner panels with stainless kick panel cover the insulated door. The door is provided with double glazed upper sash as basic, and a lower Lucite window to resist breakage. Optional fluted stainless exterior door panels are available. The door is hinged at the front lower edge and at the cylinder. The door assembly has provisions for top header and rear jam locking devices in addition to the manually actuated sliding lock bar. The door can be locked from outside with the keyed lock or with the padlock brackets at bottom of door.

DOOR CONTROL ASSEMBLY

The door control assembly consists of a valve panel and combination air/hydraulic cylinder. An air/hydraulic distribution block connects the cylinder to the control valves. Supply air to the door control assembly is provided by the manual overrule dump valve via the accessory air circuit front junction block (Figure 1).

Control Panel

The control valve panel assembly regulates the air/hydraulic flow to and from the cylinder. The control panel is mounted under the top step of the entrance stepwell. The panel is fitted with a Skinner 4-way air control solenoid valve, a normally-closed hydraulic lock solenoid valve and a pressure regulator on the air circuit. Twin pressure protection valves and a normally-open flow valve are mounted to the hydraulic circuit for the hydraulic locking function (Figure 2).

Door Cylinder

The two part cylinder is half air operated and half hydraulic. The double-acting air cylinder portion is used to open and close the door. The hydraulic portion utilizes a closed loop water/glycol mixture to help dampen and smooth door movement during operation.

AIR LOCKING CYLINDERS

The door is held in the closed position during coach operation by two locking air cylinders. The positive automatic air locking arrangement with overrule valve provides for emergency door opening. The air locks are automatically actuated via a solenoid operated valve located in the front side service door compartment, which is energized by a micro-switch located on the air cylinder pivot lever of upper hinge assembly. Single acting air cylinders with internal return springs are used to operate locks.

DOOR SWITCHES

The door is operated from inside the coach by a momentary-on switch located on the upper right-hand switch panel. Operation of the door from outside the coach is accomplished with the momentary-on switch located in the exterior switch pocket (Figure 3). The switch must be held in the desired position until the door has completed its movement. A legend plate is attached just under the switch.

OPERATION

OPENING

When either interior or exterior switches are moved to open, the valve panel's control and latching relays are energized. The latching relay supplies current to the cylinder 4-way air control solenoid valve, pressurizing the piston side and exhausts the rod end of the air cylinder portion causing the cylinder to extend. As the air cylinder rod extends or retracts, it moves the pivot lever to which it and the upper door hinge are attached.

The door air locking solenoid valve is interrupted when the latching relay is energized. This exhausts the air from the locking cylinders and releases the door air locks. The hydraulic lock solenoid valve remains de-energized during door opening. As the hydraulic piston moves forward, it forces the fluid out to the hydraulic bypass loop.

When the door is in the open position and door switch is released, the control relay is de-energized. The de-energized relay energizes the hydraulic lock solenoid valve. The pressure switch must be closed (65 psi), for current to be applied to the hydraulic lock solenoid valve. Air is applied to the hydraulic flow valve and closes the inlet to delivery ports, blocking flow and locks door in place. Locking pressures are controlled by the pressure protection valves (forward and reverse flows).

CLOSING

When either interior or exterior switches are moved to closed, the latching relay is de-energized. The 4-way valve pressurizes the rod end port of the air cylinder portion, and exhausts the piston end causing the cylinder to retract. The hydraulic lock solenoid valve remains de-energized during door closing. As the hydraulic piston moves back, it forces the fluid out to the hydraulic bypass loop. When the door is in the closed position and door switch is released, the control relay is again de-energized and hydraulic lock is applied.

When the door position micro-switch is actuated at complete entrance door closure, the latching solenoid valve is energized via the latching relay and micro-switch ground. When energized, the valve delivers air to the locking cylinders that lock the door securely.

MANUAL OVERRULE

A manually operated entrance door air dump valve is incorporated into the door control air supply circuit for emergency opening of the entrance door. When actuated the dump valve exhausts air from the locking cylinders via the quick release valve. The overrule valve is connected by cable to a pull handle located in the front junction box (Figure 4).

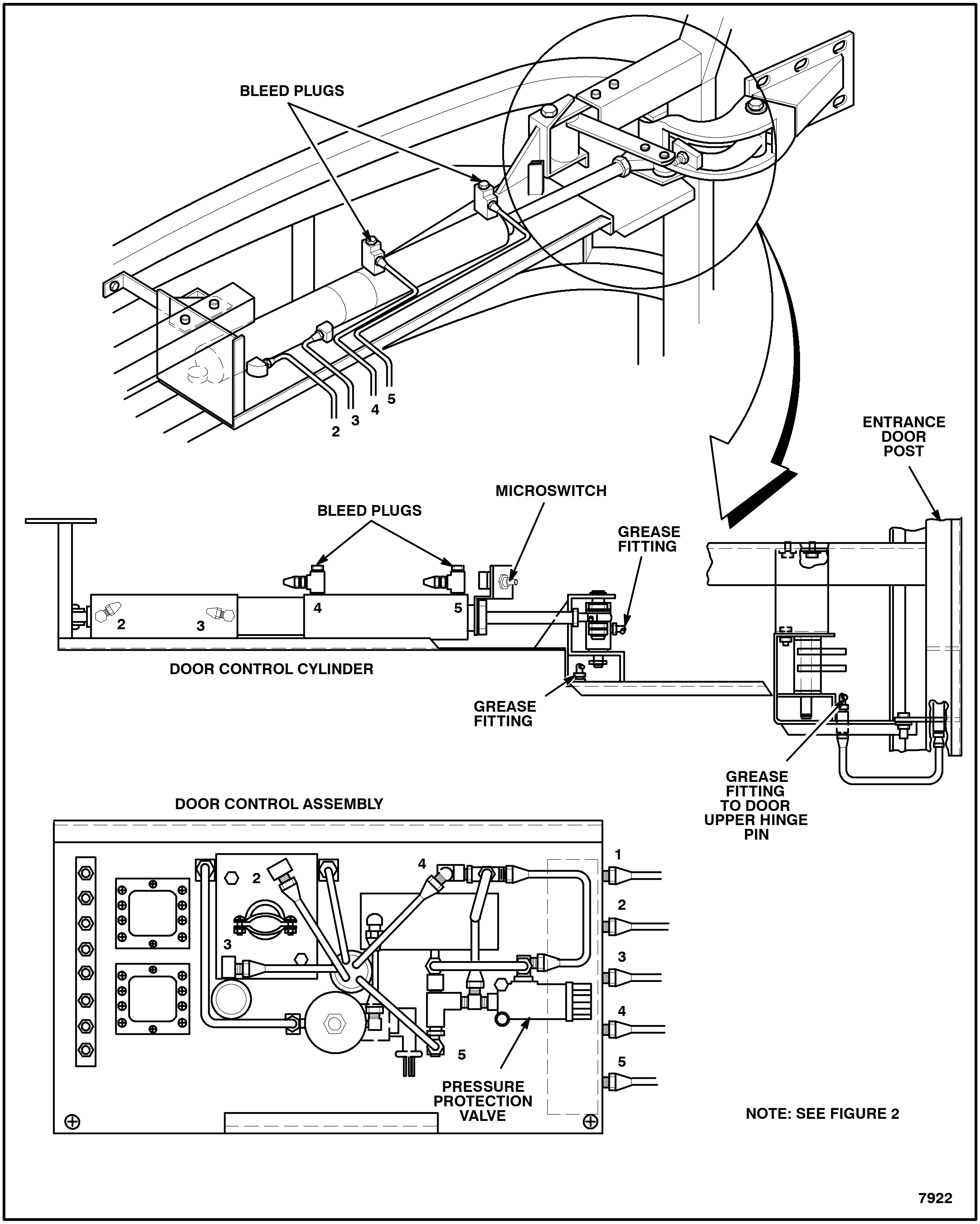

BLEED PLUGS
2
3
4
5
ENTRANCE DOOR POST
MICROSWITCH
BLEED PLUGS
GREASE FITTING
2
3
4
5
DOOR CONTROL CYLINDER
GREASE FITTING
GREASE FITTING TO DOOR UPPER HINGE PIN
DOOR CONTROL ASSEMBLY
2
3
4
5
1
2
3
4
5
PRESSURE PROTECTION VALVE
NOTE: SEE FIGURE 2
7922

Figure 1. Door Control Assembly & Cylinder

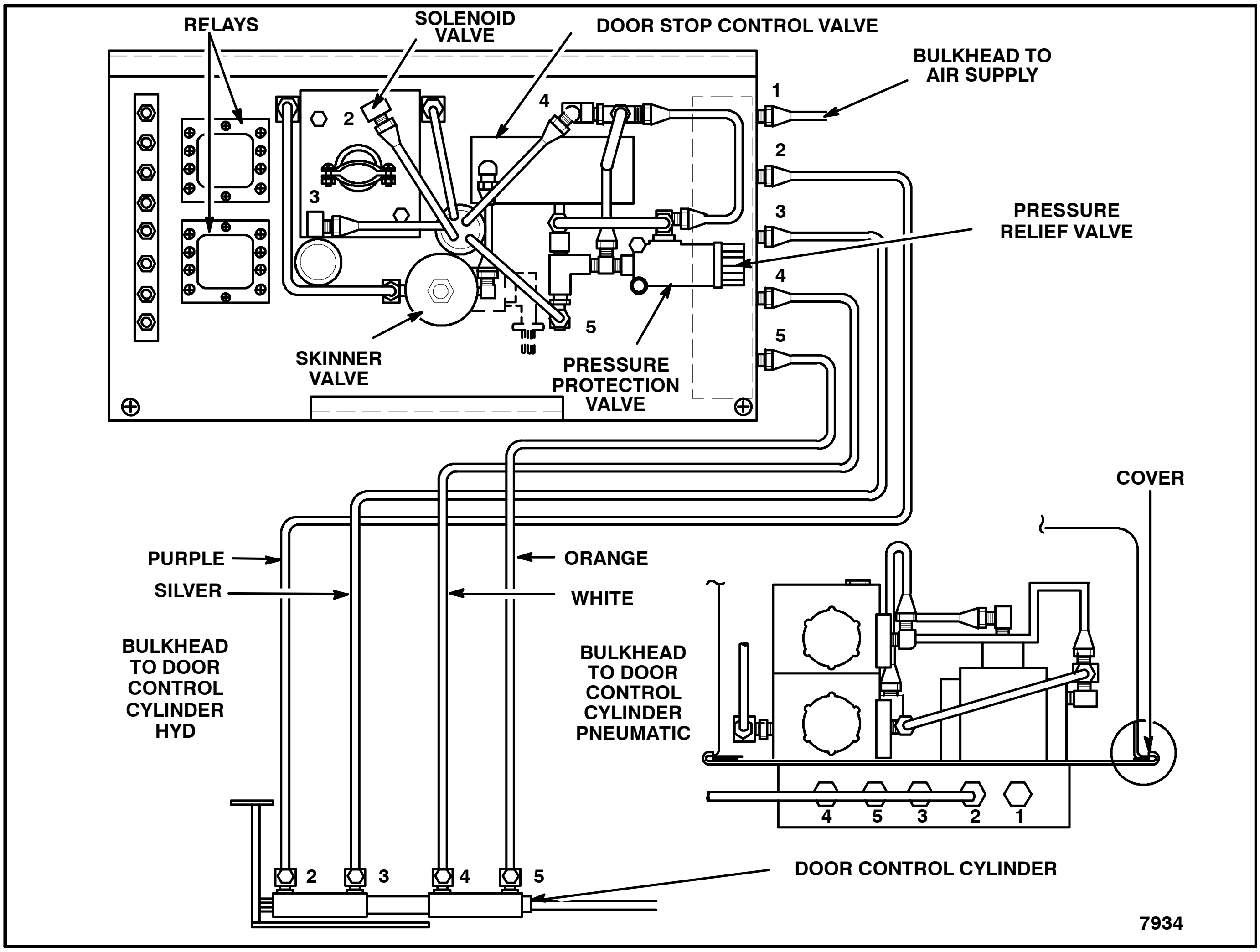

RELAYS
SOLENOID VALVE
DOOR STOP CONTROL VALVE
BULKHEAD TO AIR SUPPLY
PRESSURE RELIEF VALVE
SKINNER VALVE
PRESSURE PROTECTION VALVE
1
2
3
4
5
COVER
PURPLE
SILVER
ORANGE
WHITE
BULKHEAD TO DOOR CONTROL CYLINDER HYD
BULKHEAD TO DOOR CONTROL CYLINDER PNEUMATIC
4 5 3 2 1
2 3 4 5
DOOR CONTROL CYLINDER
7934

Figure 2. Air Operated Sedan Door Control Assembly

SWITCHES

If the driver's door switch is positioned for door opening, the exterior switch can be used to override the interior switch and close the door. If the driver's switch is positioned for door closing, the exterior switch can not override the interior switch. If either door switch is released during opening or closing function, the hydraulic lock solenoid valve would be energized and apply air to the flow valve locking the door in that location.

MAINTENANCE

ADJUSTMENT

All components of the door control system have to operate correctly and in sequence with each other. The claw mechanism and the door latch must engage each other so that positive locking is achieved when the door is closed. Before attempting to correct any door operating problem by adjusting the door control assembly, first make a check of the door to jam alignment.

The door itself must be adjusted so that it moves in and out of the door opening without binding and without being distorted. Assure that the door is not binding on front or rear posts, at top header or at bottom stepwell. If any of these conditions are occurring, adjust as follows:

Vertical Alignment

If adjustment is required, remove the required panels. Door height can be adjusted by means of the threaded upper hinge pin (Figure 5).

1. Move battery disconnect switch to the "OFF" position.
2. Disconnect lube line from elbow in bottom of hinge pin. Remove elbow and loosen jamnut at top of pin.
3. Rotate nut on bottom of pin upward or downward, depending on the desired door movement.
4. After adjustment is complete tighten upper jam nut, and reassembly door in reverse order.

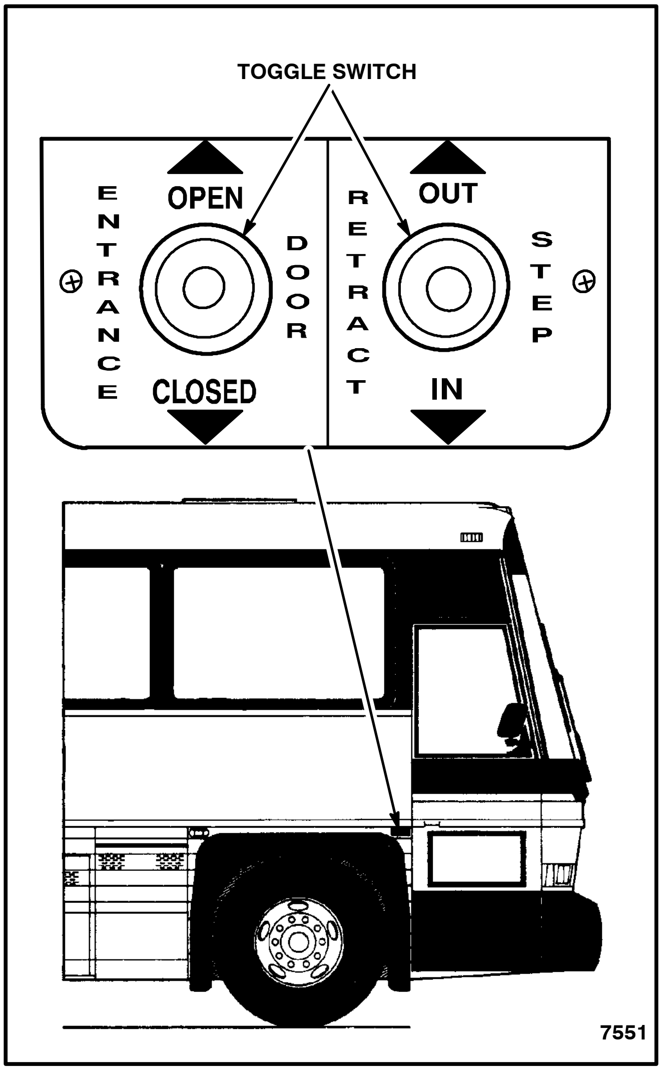


Figure 3. External Entrance Door Switch

NOTE: If door was being lowered in above adjustment and bottomed out, to lower the door further, loosen the screws securing lower hinge to door and lower door as required. Retighten screws.

Longitudinal Adjustment

To move the door forward or rearward the upper or lower hinges must be repositioned.

1. Move battery disconnect switch to the “OFF” position.

2. Loosened the bottom hinge from the body and set the door positioned.

NOTE: On coaches with entrance door padlock brackets at the bottom of the door, check that the brackets are not bent and interfering the door movement. Straighten or replace damaged brackets.

3. Loosened the upper hinge from the body and shim the door into positioned.

Lateral Adjustment

To move the door inward or outward to the jamb, the upper or lower hinge must be repositioned.

1. Move battery disconnect switch to the “OFF” position.

2. Loosened the bottom hinge from the body and shim the door into positioned.

3. Loosened the upper hinge from the body and slide hinge to set the door positioned.

NOTE: Door may not be able to open or close completely if the upper hinge to cylinder linkage is not correct. When the door is at its fully open position, the hinge must not come into contact with the front door post. There should be approximately a 1/4 inch clearance between back of upper hinge and the post. When the door is fully closed, it should come into firm contact with the seal around the door opening.

Upper Hinge Linkage Adjustment

To adjust door so that it opens fully without the hinge striking the door post, perform the following steps:

1. Move battery disconnect switch to the “OFF” position.

2. Release air from the door system (open overrule valve). Make sure the door is in the full open position.

3. Open door to point where back surface of the hinge is 1/4 inch from the jamb (post). The air cylinder rod should not be able to extend any further when the door is at this position (cylinder is bottomed out).

4. If cylinder is not bottomed out, free the ball stud end of the air cylinder rod from the pivot lever by removing the connecting pin. Pull cylinder rod out to its full length.

5. Loosen the jamnut on the uni-ball stud end and rotate uni-ball stud end until it aligns with the hole in the pivot lever.

6. Tighten jamnut and replace pivot pin.

7. Close overrule valve and check that door opens fully without hinge striking the post. Close the door - there should not be any binding. The door control cylinder shaft must be horizontally aligned with the door hinge.

NOTE: An adjustment is provided at the microswitch located behind the air cylinder pivot lever. The correct adjustment is obtained when the microswitch contacts close as the door seats against the door frame seals.

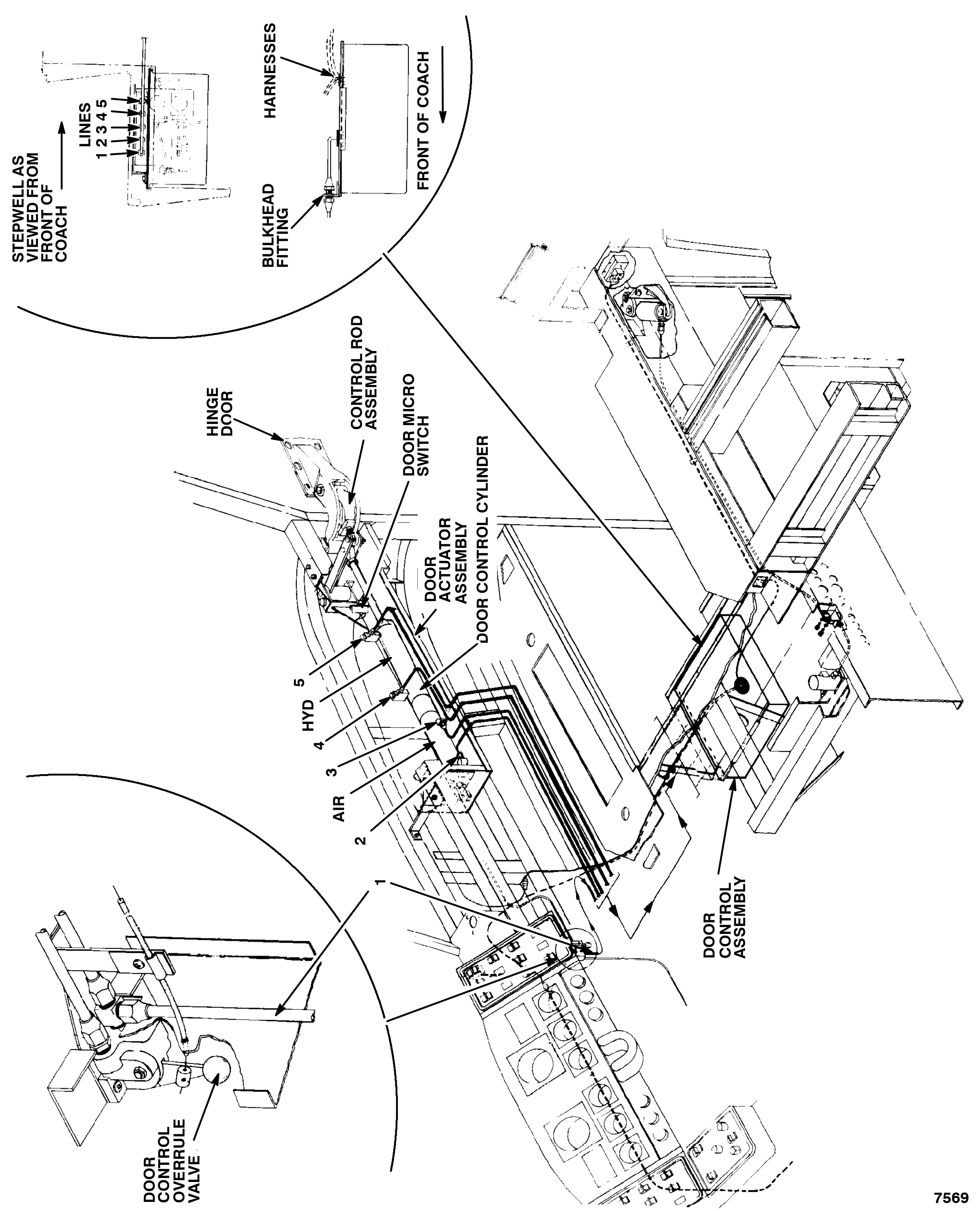

STEPWELL AS VIEWED FROM FRONT OF COACH
LINES 1 2 3 4 5
BULKHEAD FITTING
HARNESSES
FRONT OF COACH
HINGE DOOR
CONTROL ROD ASSEMBLY
DOOR MICRO SWITCH
DOOR ACTUATOR ASSEMBLY
DOOR CONTROL CYLINDER
5
HYD
4
3
AIR
2
1
DOOR CONTROL ASSEMBLY
DOOR CONTROL OVERRULE VALVE
7569

Figure 4. Air Operated Locking Mechanism

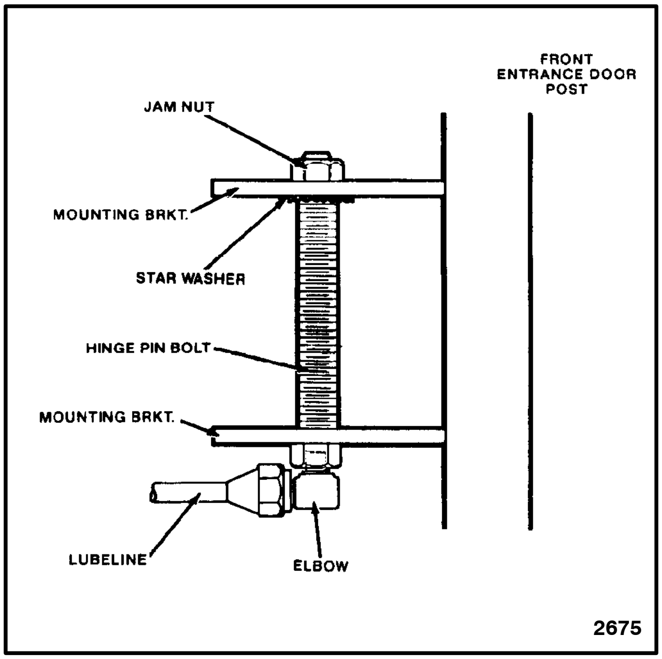

FRONT ENTRANCE DOOR POST
JAM NUT
MOUNTING BRKT.
STAR WASHER
HINGE PIN BOLT
MOUNTING BRKT.
LUBELINE
ELBOW
2675

Figure 5. Entrance Door Upper Hinge Pin

Door Claw Adjustments

Check that the door claw engages firmly with the latch pocket on the door. Insufficient engagement will allow the door to vibrate during coach travel.

> **NOTE:** Check adjustment of the upper hinge micro-switch which controls the locking claw air cylinder solenoid valve. Check that the door overrule valve is in the closed position. Check the pressure protection valves for properly setting or door could drift open while the coach is in motion.

REACH ADJUSTMENT

To adjust door claw reach follow this procedure (Figure 6).

1. Move battery disconnect switch to the “OFF” position.
2. Remove panel from rear wall of stepwell to gain access to air cylinder (1).
3. Remove shoulder bolt (6) to free yoke (5) at anchor end of air cylinder.
4. Loosen jamnut (7) and turn yoke to lengthen or shorten stroke of piston rod as necessary.
5. Tighten jamnut and reassemble.
6. If adjustment at the yoke is insufficient, the “reach” can be further adjusted by the addition or removal of shims (8) behind the cylinder mounting bracket (2).

LATERAL ADJUSTMENT

To adjust the claw’s lateral position use this procedure.

1. Move battery disconnect switch to the “OFF” position.
2. Loosen capscrews (12) mounting cylinder bracket (2) to coach.
3. Move cylinder bracket forward for less claw/latch pocket engagement and move it backward for more engagement.
4. When adjustment is complete, retighten capscrews.

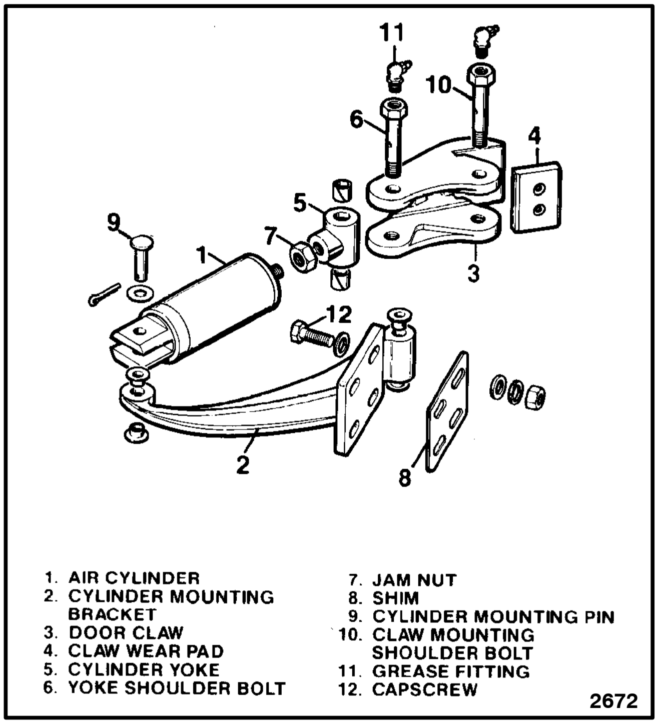

11
10
6
4
5
9
7
1
3
12
2
8
1. AIR CYLINDER
2. CYLINDER MOUNTING BRACKET
3. DOOR CLAW
4. CLAW WEAR PAD
5. CYLINDER YOKE
6. YOKE SHOULDER BOLT
7. JAM NUT
8. SHIM
9. CYLINDER MOUNTING PIN
10. CLAW MOUNTING SHOULDER BOLT
11. GREASE FITTING
12. CAPSCREW
2672

Figure 6. Entrance Door Locking Claw

Control Adjustments (Hydraulic Circuit)

The door will normally swing in or out smoothly. If a jerking motion is observed, air has entered the hydraulic system and must be bled off. The door should remain stationary when switches are released. If drift occurs the pressure protection valves are out of adjustment allowing passage of too much hydraulic fluid To correct jerking motions and to stop drift, refer to the air bleeding and pressure protection valve adjust procedures that follow.

OPENING/CLOSING SPEED

The opening and closing speed of the door is a function of the length of the hydraulic line between the cylinder’s hydraulic outlet and inlet. The line installed at the factory is of a length to produce a door opening/closing speed of three to four seconds. Any restriction of this line will affect the door speed. If the speed is more than four seconds, remove the line and check the ends of the line. Occasionally the ends may require deburring. Ream the line ends to the full inside diameter of the tubing. After reinstalling the line, bleed the air which has entered the system, following the air bleeding procedure above. If the line has to be replaced due to damage, it must be the same length as the old line or the door speed will be affected.

NOTE: The pressure protection valves do not control the opening/closing speed of the door. Do not attempt to adjust speed with these valves.

PRESSURE PROTECTION VALVE ADJUSTMENT

The pressure protection valves are normally set at 1/2 turn of the adjusting knob from the closed position.

If creeping of the door occurs, check the position of the adjusting knob on the appropriate pressure protection valve. Inward movement is controlled by the right-hand valve, outward movement by the left-hand valve. To set the valve, turn the adjusting knob all the way in and then back it off 1/2 turn. Check the door for creeping.

NOTE: Correct a creeping condition by first adjusting the pressure protection valves. If problem persists bleed the hydraulic circuit.

If the door still creeps, tighten the adjusting knob in small increments, checking for creeping after each adjustment. If creeping persists when the knob is turned all the way in, then either the door stop control valve is defective and will require repair or replacement, or there is air in the system that will have to be bled off. Refer to bleeding procedure above.

⚠ **CAUTION** ⚠

Do not leave either pressure protection valve set in the fully closed position; this will prevent the movement of hydraulic fluid in or out of the cylinder. External force applied to the door under these conditions can damage the door operating mechanism.

AIR BLEEDING

Use this procedure to remove air from the hydraulic system.

1. Move battery disconnect switch to the “OFF” position.
2. Open the door control overrule valve; this removes air pressure from the hydraulic control valve and allows the hydraulic fluid to circulate in the system.
3. Remove pipe plugs (at lines 4 and 5)from the top of the cross-shaped fitting connected to the door control cylinder. If necessary, fill hydraulic system using a 50% ethylene glycol and 50% water mixture. Fill system until fluid level is at bottom of pipe plug ports.
4. Install a length of clear plastic tubing using a compression fitting at the pipe plug port. Tubing length needs to be sufficient to reach into a clear quart-size container which is positioned above the air cylinder. Fill container with 50-50 antifreeze/water mixture. Insert tube into it with end of tube well below surface of liquid.
5. Manually opening and closing the door will pump the hydraulic fluid through the cylinder and control valve loop. Air will be expelled through the plastic tubing. Air bubbles will be visible as they pass through the tubing and through the fluid in the reservoir. Continue the pumping action until no more bubbles are expelled. The antifreeze/water mixture will be drawn into the system to replace the expelled air.
6. At this point some air may still be trapped in the pressure protection valves and in their lines and fittings. To complete the bleeding, rotate the knobs on these valves three full turns counterclockwise. Close the door overrule valve and open and close the door, using the door control switch on the dash. Continue cycling door until no bubbles are visible in tubing or reservoir.
7. Rotate knobs on pressure protection valves to a fully closed position (flush with the stop nut) and then back off $^1/_2$ turn.
8. Remove the plastic tubing and fitting from the pipe plug ports; reinstall the pipe plugs.
9. Recycle door, checking for jerking motion or creeping when door is in stopped position. Repeat procedure if jerking or creeping occurs.

Control Adjustments (Air Circuit)

The door will normally swing in or out with speeds of three to four seconds. If the door takes to much time, check the pressure setting on the regulator valve.

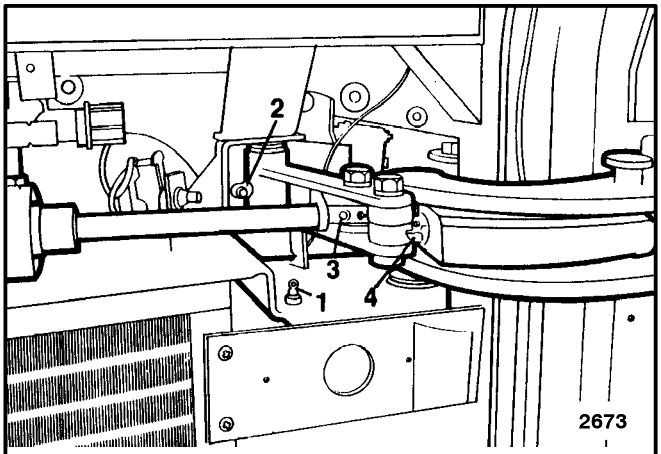
LUBRICATION

Door Hinge And Claw

Lubrication of the door hinges and latching claw is important for smooth and trouble-free operation of the sedan door. The entrance door hinges and claw pivots should be lubricated through the grease fittings at approximately 10,000 miles (16,000 km) intervals. Lubricate with specification S-16 or S-17 (Multi-Purpose Grease).

HINGES

Keeping the pivot points well lubricated will aid in providing a free and smooth door movement. Grease fittings are provided at these points. The upper hinge has a lubrication fitting on the bottom of the hinge pin and a remote fitting as shown in (Figure 7). All of the upper hinge lubrication points are accessible by simply removing the vinyl door hinge cover.



1. Upper hinge pin remote grease fitting
2. Pivot lever grease fitting
3. Air cylinder rod end grease fitting
4. Link between pivot lever and hinge grease fitting

Figure 7. Upper Hinge Lubrication Points

1. Move battery disconnect switch to the “OFF” position.
2. Follow steps 1 thru 3 of the “Cylinder Removal” procedure.
3. Upper door hinge grease fitting is in a “remote” location on the right-hand end of the air cylinder mounting bracket.
4. Fixed end of the pivot lever grease fitting is on side of the pivot housing.
5. Air cylinder rod end at the pivot lever grease fitting is on side of the “eye.”
6. “Eye” connecting the pivot lever to the upper door hinge grease fitting is on side of the “eye.”

The lower hinge is lubricated by means of a grease fitting on the side of the hinge and just to the rear of the front bumper.

LOCKING CLAW

It is important to keep the locking claw well lubricated. If it becomes dry, it will tend to drag and may fail to engage or disengage in a timely sequence with the door air cylinder. Two grease fittings are located at the top of the claw, and can be accessed by opening the entrance door.

LOCK CONTROL SOLENOID VALVE

The door control solenoid located in the spare tire compartment controls the air supply to the door lock cylinder (Figure 8).

Removal

1. Move battery disconnect switch to the “OFF” position.
2. Release air from the door system (open overrule valve). Make sure the door is in the full open position.
3. Disconnect all air tubing and wiring harness from valve.
4. Unfasten and remove valve from the compartment.

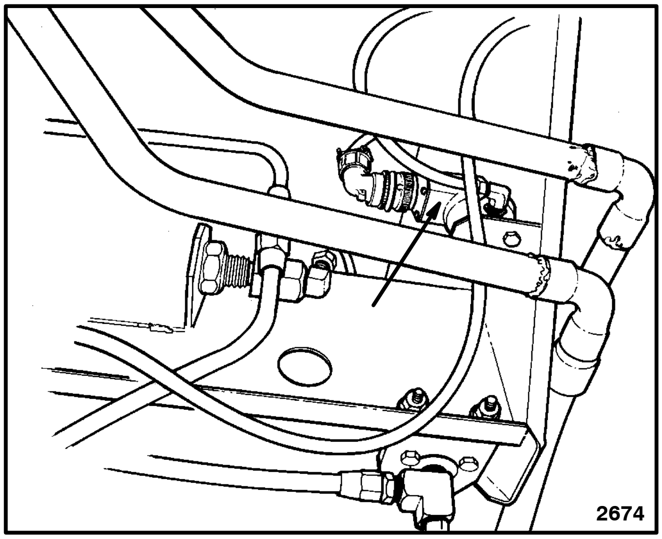


Figure 8. Entrance Door Solenoid Valve

CAUTION

Do not use a pipe wrench; a wrench may crush the sleeve assembly and make the valve inoperative.

Disassembly

If the solenoid has failed to operate, the coil should be checked to make sure it is not shorted or open. Occasionally, valves may leak at the flange seal which may damage the coil. A flange leak may be corrected by tightening the sleeve assembly into the valve body and/or replacing the seal (Figure 9).

1. Remove nut at top of coil cover, cap, coil housing and coil can then be removed from body.
2. Unscrew the sleeve assembly from the body.
3. If the valve leaks at the seat, or the plunger sticks in the energized position, examine the soft inserts in the plunger and the inside of the sleeve assembly for the presence of excessive dirt or wear. If the inserts show considerable wear, the plunger should be replaced.
4. If the solenoid develops a loud buzzing noise, examine the inside of the sleeve assembly and upper portion of the plunger. Remove all foreign matter imbedded in these parts.

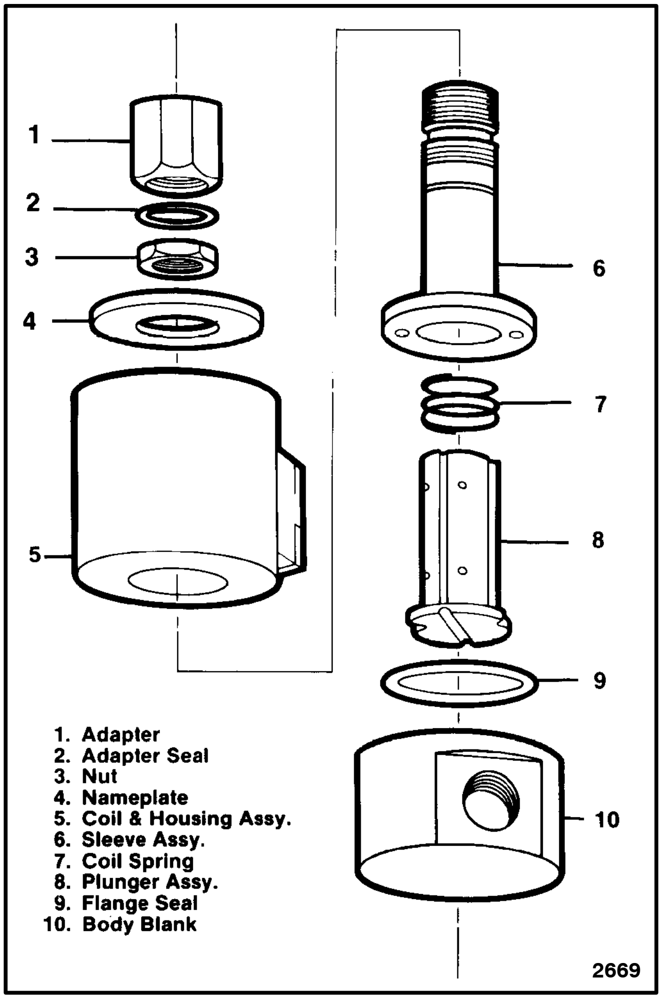


Figure 9. Entrance Door Solenoid

5. If the valve leaks internally, examine the piston insert for excessive wear. Also inspect main exhaust orifice for dirt accumulation, scratches and nicks. Replace parts as necessary.

6. If the valve is sluggish during operation, check for dirt accumulation or wear on both piston and piston bore. The piston should slide freely into the piston bore without binding. Inspect and clean all passageways.

Assembly

1. Reassemble the valve by following the disassembly procedure in reverse order. Make sure the seal at the flange end of the assembly and the return spring are in place when the sleeve is screwed into the body.

2. After screwing the flange into the body and before assembling the coil to the valve, it is advisable to apply air pressure to the part which leads to the body chamber and check for leakage around the flange. If the valve has a sleeve port, this port at the top of the valve must be capped to make this test. If the medium is air or gas, leakage can be noted by applying water to the joint and watching for air bubbles. If the medium is liquid, leakage is readily apparent.

⚠ CAUTION ⚠

Do not excessively tighten the nut at the top of the coil housing; doing so will put undue strain on the sleeve assembly.

Installation

1. Reinstall the valve in reverse order of the “Removal” procedure.

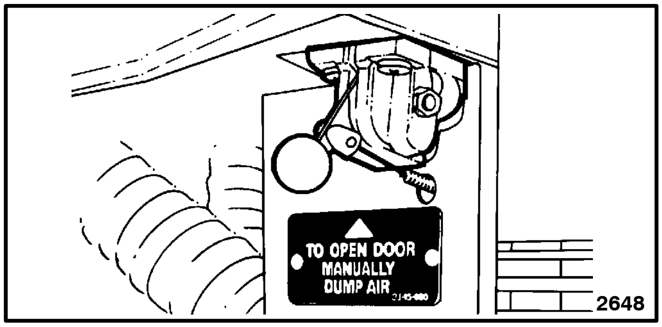


Figure 10. Air Dump Valve

MANUAL AIR DUMP

If the electrical circuit to the solenoid valve fails while the operator is inside the vehicle, a hand operated air valve is provided which allows exhausting of all air from the door operating cylinder (Figure 10). With the air exhausted, the door can be manually pushed to the open position. The air dump valve is located to the right of driver’s position and below the dash panel. This valve can be identified by a legend plate with instructions for use, and is further identified by a lever with a small red knob.

In the event that an electrical malfunction occurs while the operator is outside the vehicle, the above dump valve can also be controlled from outside the vehicle. A push-pull control cable is located in the left front electrical junction box (Figure 11).

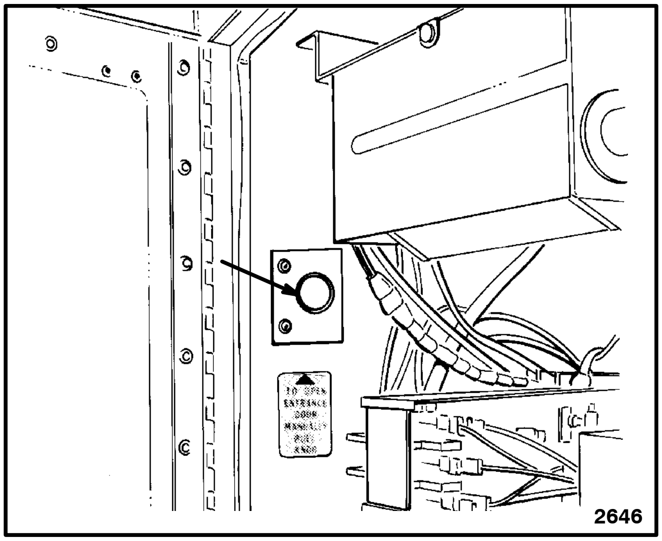


Figure 11. External Air Dump Valve

The control cable can be reached by opening the exterior junction box access door. By pulling the black knob to full out position, the air dump valve described above is actuated to the exhaust position. The door can then be manually pulled to the open position from outside the vehicle.

HYDRAULIC FLOW CONTROL VALVE

The air-assisted hydraulic flow control valve may be repaired if the above pressure protection valve adjustment procedure reveals that it is allowing hydraulic fluid to pass when it is in the closed position (Figure 12).

Removal

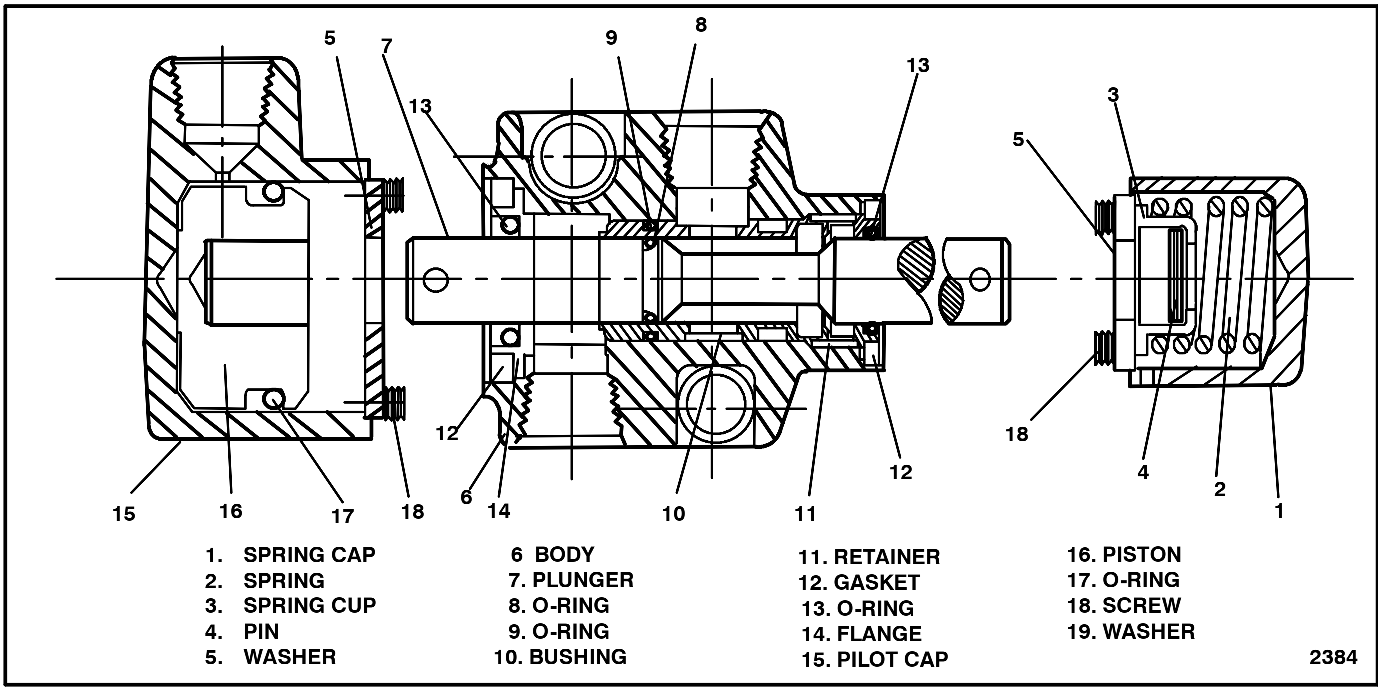
1. Move battery disconnect switch to the "OFF" position.
2. Release air from the system by opening the overrule valve.
3. Unfasten and remove control valve panel cover.
4. Disconnect and drain hydraulic circuit at control valve.
5. Disconnect all other air or hydraulic tubing attached to control valve.
6. Unfasten and remove control valve from panel.

Installation

1. Reinstall the valve in reverse order of the "Removal" procedure.

DOOR LOCKING CYLINDERS

The entrance door locking air cylinders should be lubricated through air hose connector at approximately 50,000 miles (80,000 km) intervals. Lubricate with specification S-6 (Heavy-Duty Engine Oil - 10W).



1. SPRING CAP
2. SPRING
3. SPRING CUP
4. PIN
5. WASHER
6. BODY
7. PLUNGER
8. O-RING
9. O-RING
10. BUSHING
11. RETAINER
12. GASKET
13. O-RING
14. FLANGE
15. PILOT CAP
16. PISTON
17. O-RING
18. SCREW
19. WASHER

Figure 12. Door Stop Control Valve

Removal

SIDE LOCKING CYLINDER

The entrance door locking claw air cylinder is located in the pocket below the passenger modesty panel (Figure 13).

1. Move battery disconnect switch to the “OFF” position.
2. Open door fully and release air from the system by opening the overrule valve.
3. Unfasten and remove the cover panels of pocket and claw.
4. Disconnect the air tubing attached to cylinder.
5. Disconnect and remove pin attaching cylinder to rear mounting bracket.
6. Disconnect and remove shoulder bolts attaching claw to pivot bracket and rod end connector.
7. Remove cylinder from pocket.

HEADER LOCKING CYLINDER

The entrance door header locking cylinder is located behind the transom panel above door (Figure 14).

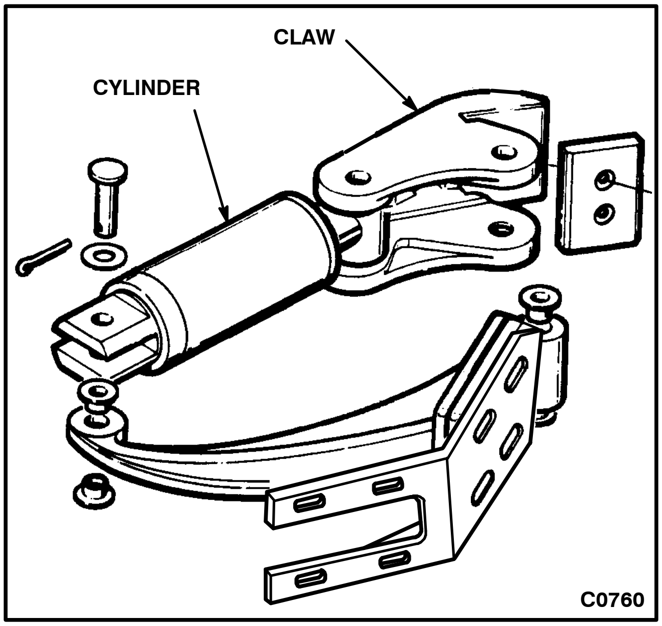


Figure 13. Side Locking Cylinder

1. Move battery disconnect switch to the “OFF” position.
2. Open door fully and release air from the system by opening the overrule valve.

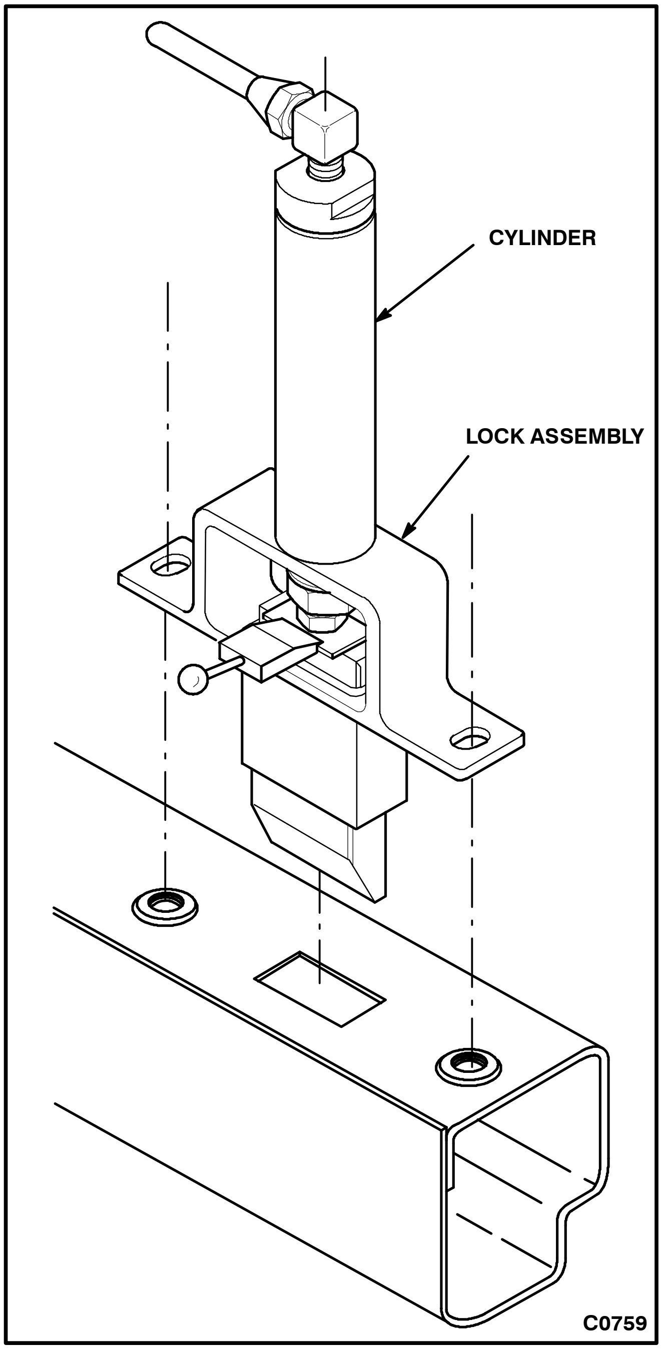


Figure 14. Header Locking Cylinder

3. Unfasten and remove the transom window interior panel.

NOTE: If equipped with monitor, disconnect and remove.

4. Disconnect the air tubing attached to cylinder.
5. Unfasten and remove the mounting bracket and cylinder assembly from door header.
6. Unfasten hex nut and disassemble cylinder from mount bracket.

NOTE: When overhauling air cylinders, replace all seals, felts, cups and O-rings. New parts should be coated with oil before assembly.

Installation

1. Reinstall the cylinders in reverse order of their “Removal” procedures, and check air cylinder for leakage. Readjust the cylinder and claw reach and/or adjustment of cylinder latch to door striker plate.

DUAL ACTUATING CYLINDER

A combination air/hydraulic cylinder actuates the door. The hydraulic portion of the cylinder buffers the piston against abrupt movements as air pressure is applied (Figure 15).

NOTE: Effective with unit 45774 a new entrance door actuating cylinder was introduced.

Removal

1. Move battery disconnect switch to the “OFF” position.
2. Open door fully and release air from the system by opening the overrule valve.
3. Remove the driver’s HVAC system front panel.
4. Unfasten and remove the boot panel mounted to dash frame, and slide boot up hinge arm.
5. Disconnect and drain hydraulic circuit at cylinder.
6. Disconnect all other air or hydraulic tubing attached to cylinder.
7. Disconnect and remove pin attaching cylinder to rear mounting bracket.
8. Disconnect and remove shoulder bolt attaching rod end to pivot lever and bracket.
9. Remove cylinder from pocket.

NOTE: When repairing the cylinder, remove old O-rings and seals. Do not damage retaining grooves or sealing surfaces by using sharp tools. Thoroughly clean all parts and when installing seals apply a thin film of O-ring grease.

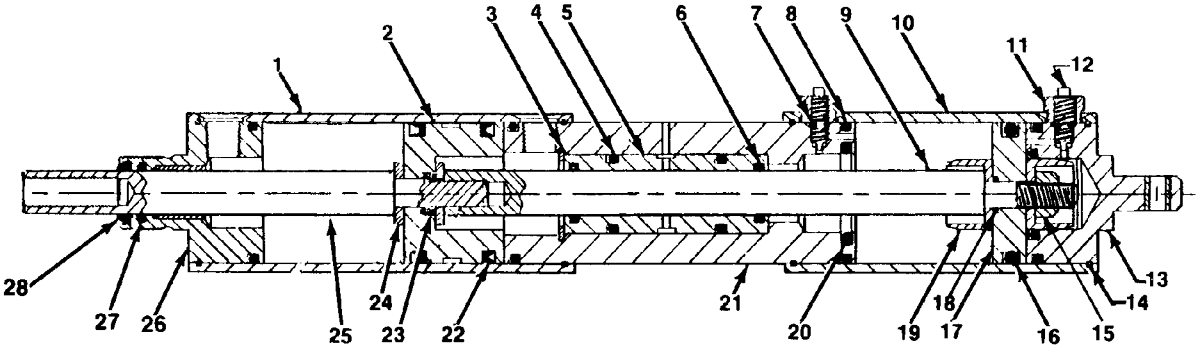
Installation

1. Reinstall the cylinder in reverse order of the “Removal” procedure, and check cylinder for air or hydraulic fluid leakage.

DOOR SEAL REPLACEMENT

The entrance door outer seal consists of three pre-cut seals: front, upper and rear (Figure 16). To replace the seals follow the procedure

1. Open the entrance door completely, exposing the door frame.
2. Remove the aluminum extrusion mounting screws and retain.



1. Barrel
2. Piston
3. Seal
4. O-ring
5. Sleeve
6. O-ring, Rod Gland
7. O-ring
8. O-ring, Head
9. Piston Rod
10. Barrel
11. Port Fitting
12. Adjusting Screw
13. Rear Head
14. Feed Ring Wire
15. Locknut
16. O-ring, Piston
17. Piston
18. O-ring
19. Collar
20. O-ring
21. Barrel
22. Seal
23. Seal
24. Spacer
25. Piston Rod
26. Front Head
27. O-ring, Rod Gland
28. Wiper

Figure 15. Sedan Door Operating Cylinder

3. Remove all aluminum extrusions and retain.

4. Remove the outer seal and bumper assembly from the aluminum extrusion and discard. Retain the existing interior seal, if not replacing.

5. Scrape and clean all residual sealer from the door frame and back of aluminum extrusion.

6. Install the new seals (front, upper, and rear) into the aluminum extrusion.

7. Place a 1/4 inch bead of Dolphinite, or equivalent, on the frame, running right over the screw mounting holes.

8. Reinstall the aluminum extrusions and fasten with the retained screws.

9. Trim excess seal from front and rear seals at bottom of the door frame.

10. Secure seals at corners with rubber adhesive.

QUICK-RELEASE VALVE

The quick release valve should have an “Operational and Leakage Test” performed every 50,000 miles (80,000 km), 1,500 operating hours (Figure 17).

Operating and Leakage Test

1. Make and hold a full brake application of approximately 80 psi (552 kPa). For QRN valves apply a 100 psi pressure.

2. Coat exhaust port with soap solution. Leakage of a one inch bubble in three seconds is permitted.

3. Coat the valve body and cover. No leakage is permitted.

NOTE: If the quick-release valve does not function properly or leaks excessively, it should be replaced or repaired as outlined below.

The quick release valve should be removed, disassembled, cleaned and inspected every 100,000 miles (161,000 km), 3,000 operating hours. Replace any parts found to be worn or damaged.

Removal

1. Place battery disconnect switch to “Off”. Block or hold vehicle by some means other than air brakes.

2. Disconnect the supply and delivery lines at the valve.

3. Unfasten mounting bolts and remove valve.

NOTE: QR-1 valves have a metal body, while the QRN valves have nylon bodies. Both types of valves may be repaired.

Disassembly

1. Unfasten the four flange screw or nuts and separate the two body halves.

2. Remove the sealing O-ring and diaphragm from between the body halves.

3. Clean all parts in cleaning solvent, and check the interior valve body halves for corrosion, pitting or nicks. Replace the valve assembly if any are found.

NOTE: It is recommended that the diaphragm and sealing ring always be replaced.

Assembly

1. Center the diaphragm in the upper body half, and position the O-ring on the lower body half.

2. Place together, install the cover fasteners and torque evenly to 60 in-lbs (6.78 N•m).

Installation

1. Install the quick release valve in the reverse order of the “Removal” procedure.

NOTE: When installing fitting to the QRN valve do not torque the supply beyond 12 ft-lbs (16.3 N·m), or the delivery over 10 ft-lbs (13.6 N·m).

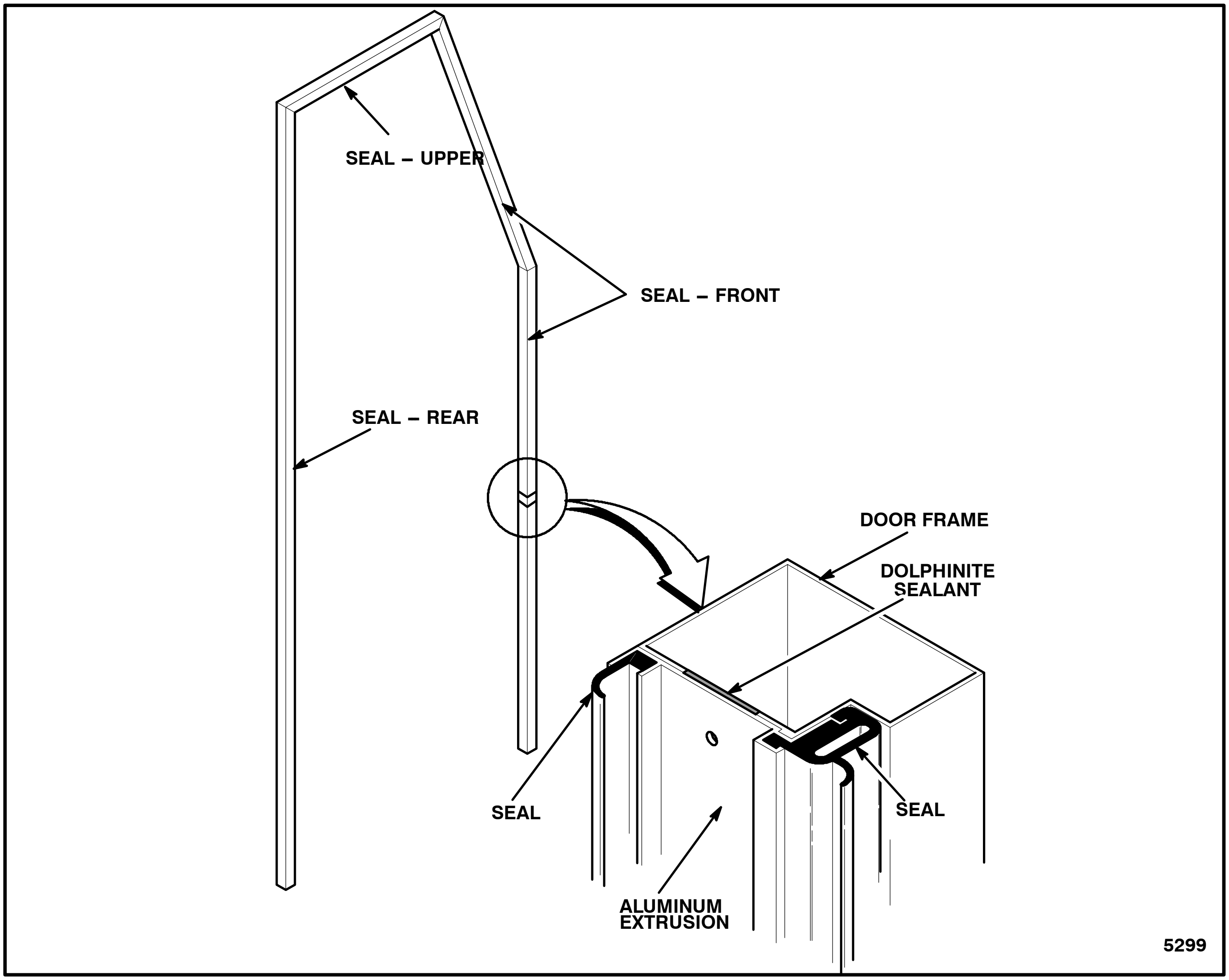

SEAL – UPPER
SEAL – FRONT
SEAL – REAR
DOOR FRAME
DOLPHINITE SEALANT
SEAL
SEAL
ALUMINUM EXTRUSION
5299

Figure 16. Entrance Door Seals

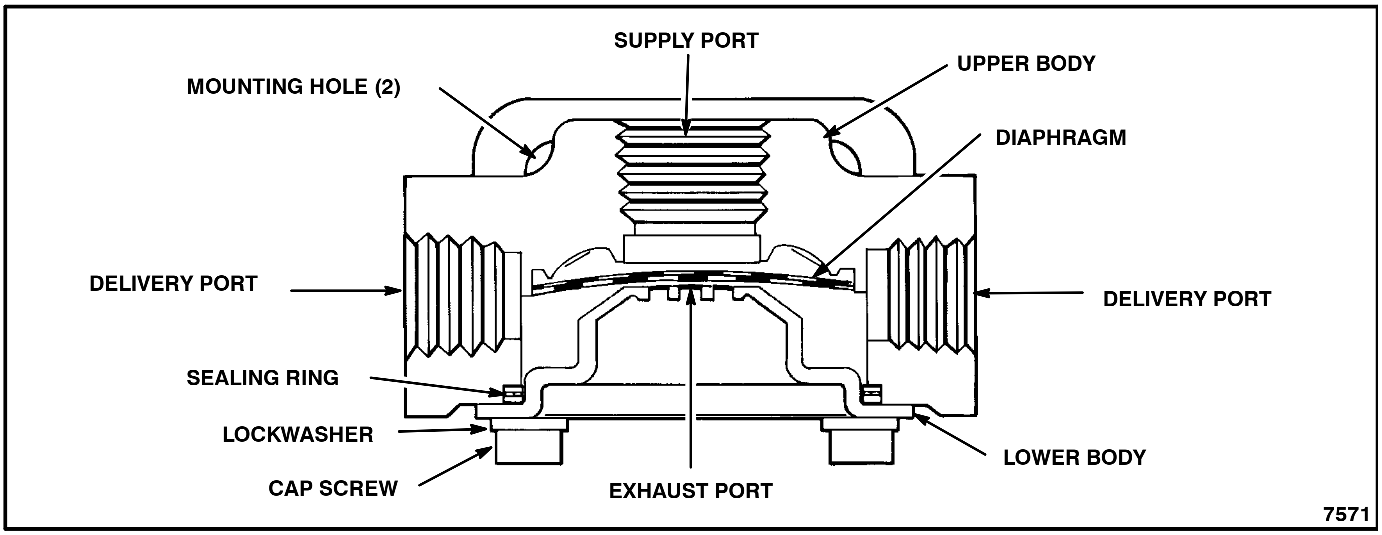

SUPPLY PORT
MOUNTING HOLE (2)
UPPER BODY
DIAPHRAGM
DELIVERY PORT
DELIVERY PORT
SEALING RING
LOCKWASHER
LOWER BODY
CAP SCREW
EXHAUST PORT
7571

Figure 17. Quick-Release Valve

BI-PARTING ENTRANCE DOOR

GENERAL DESCRIPTION

The bi-parting type entrance door is utilized mainly on coaches designated for transit service. Coaches equipped with the bi-parting entrance door feature can quickly open and close the door to board or off load passengers. This type door has front and rear door leaf panels which move outward and away from each other as the door is opened. This type door can provide a clear opening of approximately 24 x 83 inches (609.6 x 2108 mm).

Opening and closing of the door is accomplished by electro-mechanical and pneumatic devices. An air control solenoid valve in conjunction with two dual acting air cylinders provide the actuating movement. Two vertical shaft assemblies are installed at each side of the door opening onto the bearing box. Each shaft is attached by arms to a door leaf panel and air cylinder. Rotation of the front and rear shaft assemblies cause the opening and closing function. Interior and exterior switches are provided for the operator's convenience.

COMPONENTS

DOOR LEAF PANELS

The door leaf panels are shaped to fit the entrance opening and provide for front and rear shaft attachment. Each door leaf panel has an upper sash which is double glazed with tempered safety glass and a lower sash which is a clear Lucite panel. This panel resists breakage from any rocks or gravel thrown by the wheels of passing vehicles. Meeting edges of the leaves are provided with flexible rubber cushions 2 inches (51 mm) wide for passenger protection.

BEARING BOX

The bearing box assembly contains the lower stabilizing rod assembly. This rod connects lever arms of each shaft assembly to help coordinate movements of the two door leaf panels. The box provides front and rear cut-outs for actuating shaft bearing mountings.

SOLENOID VALVE

A skinner four-way, two-position, 24 volt, dual solenoid valve controls the flow of air to the cylinder ports. One valve portion is normally-open, while the other is normally-closed. The valve is located in the pocket above the driver's HVAC.0 system.

SHAFT ASSEMBLIES

The vertical shaft assemblies are installed at each side of the door opening. The shaft rotates in bearing blocks attached to the coach body, and on bearing assemblies mounted on the bearing box. The control arm assembly is attached to the bottom arm of each shaft assembly to assure unison in movement. A stabilizing tube assembly is attached to the top bearing block arm and door leafs retain proper glide path.

AIR CYLINDERS

Door actuation is provided by two dual acting air cylinders. The air cylinders are attached to each of the actuating shafts by control arms. The front leaf's cylinder is located in the pocket above the driver's HVAC system. The rear leaf's cylinder is located in the pocket below the modesty panel. The extend position closes the door and the retract position opens the door.

DOOR SWITCHES

The momentary-on type door switches are located on the right hand switch panel and adjacent the kneel switch in the exterior switch pocket. The exterior switch must be in the open position in order for the interior switch to open and close the doors.

OPERATION

With the interior door control switch positioned to "CLOSED", the four-way solenoid valve is energized. The normally open portion closes supply air to the retract ports of the air cylinders, while the normally closed portion opens supply air to the extend ports of the air cylinders. Simultaneously, air is allowed to exhaust from retract ports of the cylinders. The extended cylinders push the shaft arms outward, and cause the shaft to rotate. The rotating shafts pulls the door arms in, moving the door leaf panels inward and toward each other at entrance opening center.

When the switch is repositioned to "OPEN", the solenoid valve is de-energized. the normally open portion opens supply air to the retract ports of the air cylinders, and the normally closed portion closes supply to the extend ports of the air cylinders allowing air to exhaust from the extend ports of the cylinders. The retracted cylinders pull the shaft arms inward, cause the shaft to rotate, pushing the door arms out and move the door leaf panels outward and away from each other opening the entrance. Supply air is routed through the manual dump valve located near the driver. In emergencies the valve allows for exhausting of all air from the door operating cylinder, and manual opening of the doors (Figure 18).

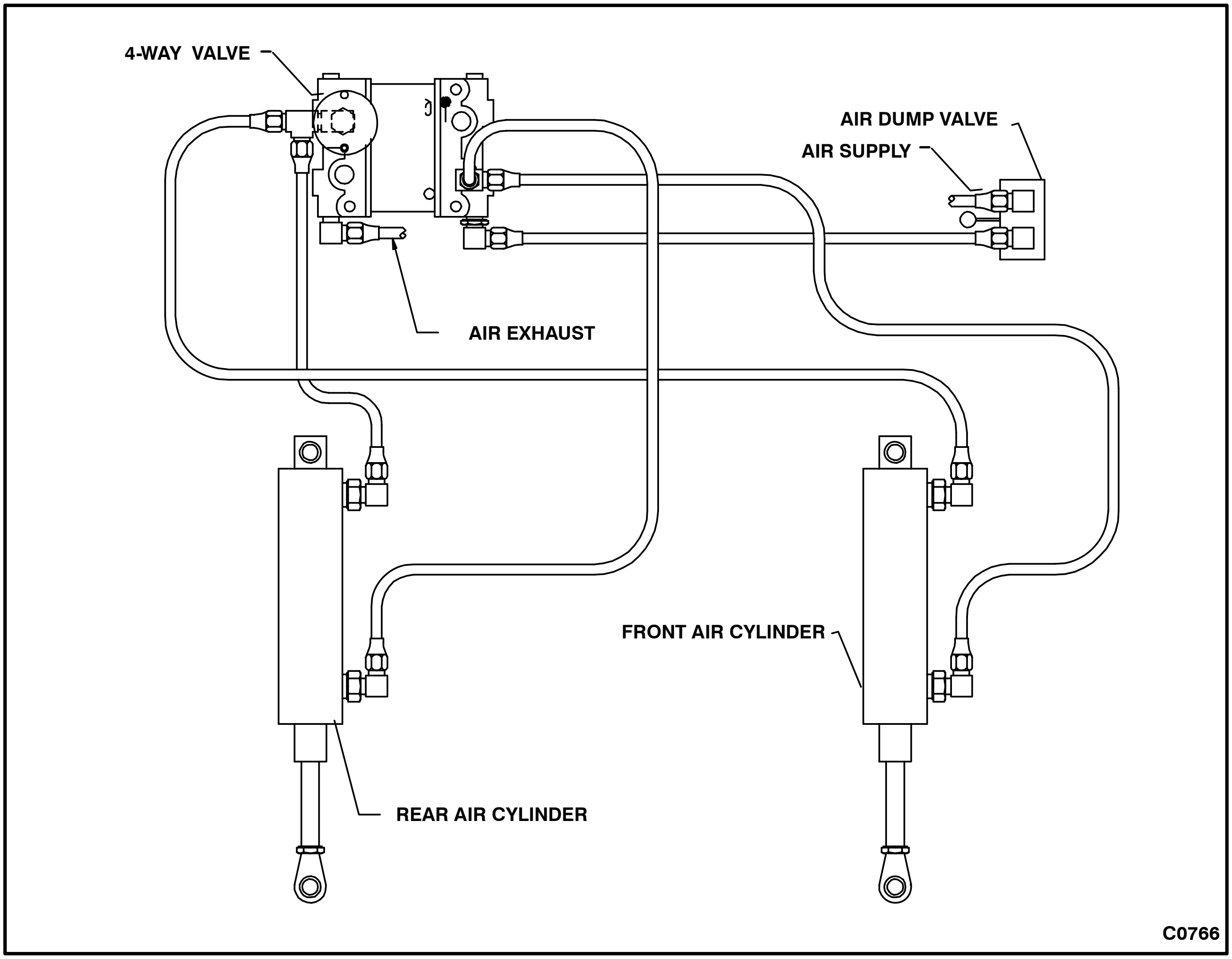

4-WAY VALVE
AIR DUMP VALVE
AIR SUPPLY
AIR EXHAUST
FRONT AIR CYLINDER
REAR AIR CYLINDER
C0766

Figure 18. Bi-Parting Door Pneumatic Diagram

MAINTENANCE

ADJUSTMENT

After making the following adjustments, lubricate all bearing and pivots using lubrication specification S-16 thru S-20 (Mutli-Purpose Grease), and wipe excess grease from all components. After lubrication, manually move shafts and linkage through full travel. Check for smooth movement without any binding. Action should be stiff but not excessively hard to move manually.

Shaft Bearing Blocks

Check fore and aft dimension between shaft centers (Figure 19). Remove shims between brackets and spacers if short. Add shim pack to the underside of standard spacer if long. Ensure that both brackets are shimmed equally.

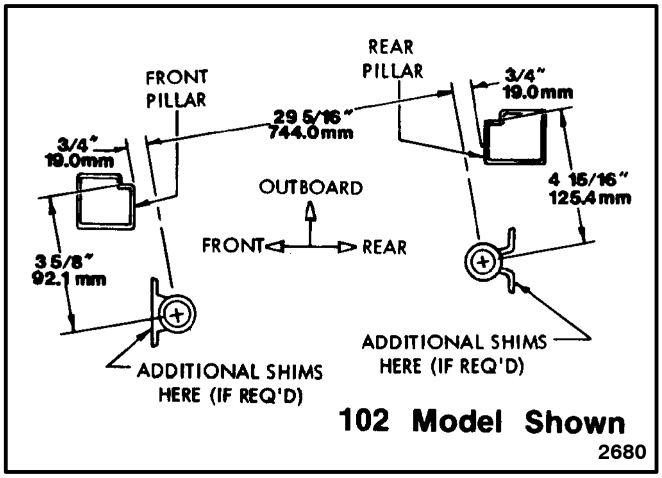

REAR PILLAR
FRONT PILLAR
3/4" 19.0mm
29 5/16" 744.0mm
3/4" 19.0mm
OUTBOARD
4 15/16" 125.4mm
FRONT
REAR
3 5/8" 92.1 mm
ADDITIONAL SHIMS HERE (IF REQ'D)
ADDITIONAL SHIMS HERE (IF REQ'D)
102 Model Shown
2680

Figure 19. Shaft Bearing Blocks

1. Turn disconnect switch off, and actuate the door's manual air dump valve.
2. Unfasten bearing block mountings, and install or remove shims as required.

3. Refasten bearing block mountings, and recheck dimensions.

Shaft Bumper Stops

Check that stops are contacted and that arms are not in contact with door frame. Turn stop screw in or out as required (Figure 20).

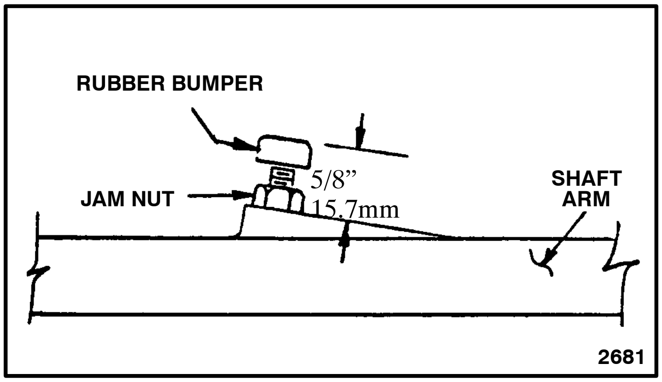


Figure 20. Shaft Bumper Stops

1. Turn disconnect switch off, and actuate the door’s manual air dump valve.
2. Unfasten jamnut and adjust rubber bumper stops on both shafts to 5/8 inch (15.9 mm).
3. Tighten jamnut to lock bumper in position.

NOTE: Doors should open to a clear opening of approximately 24 inches.

Shaft Arm Rod Ends

Check rod end stick-out, and adjust for minimum door movement (Figure 21). This adjustment is critical in attaining correct door operation.

1. Turn disconnect switch off, and actuate the door’s manual air dump valve.
2. Unfasten jamnut and adjust rod ends on both shaft arms to 1-1/2 inches.
3. Tighten jamnut to lock rod end in position.

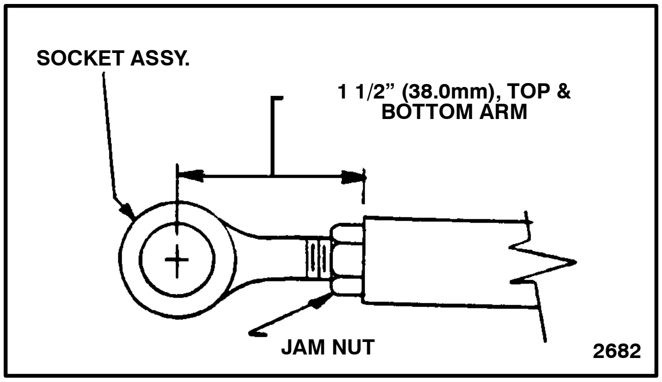


Figure 21. Shaft Arm Rod Ends

REMOVAL

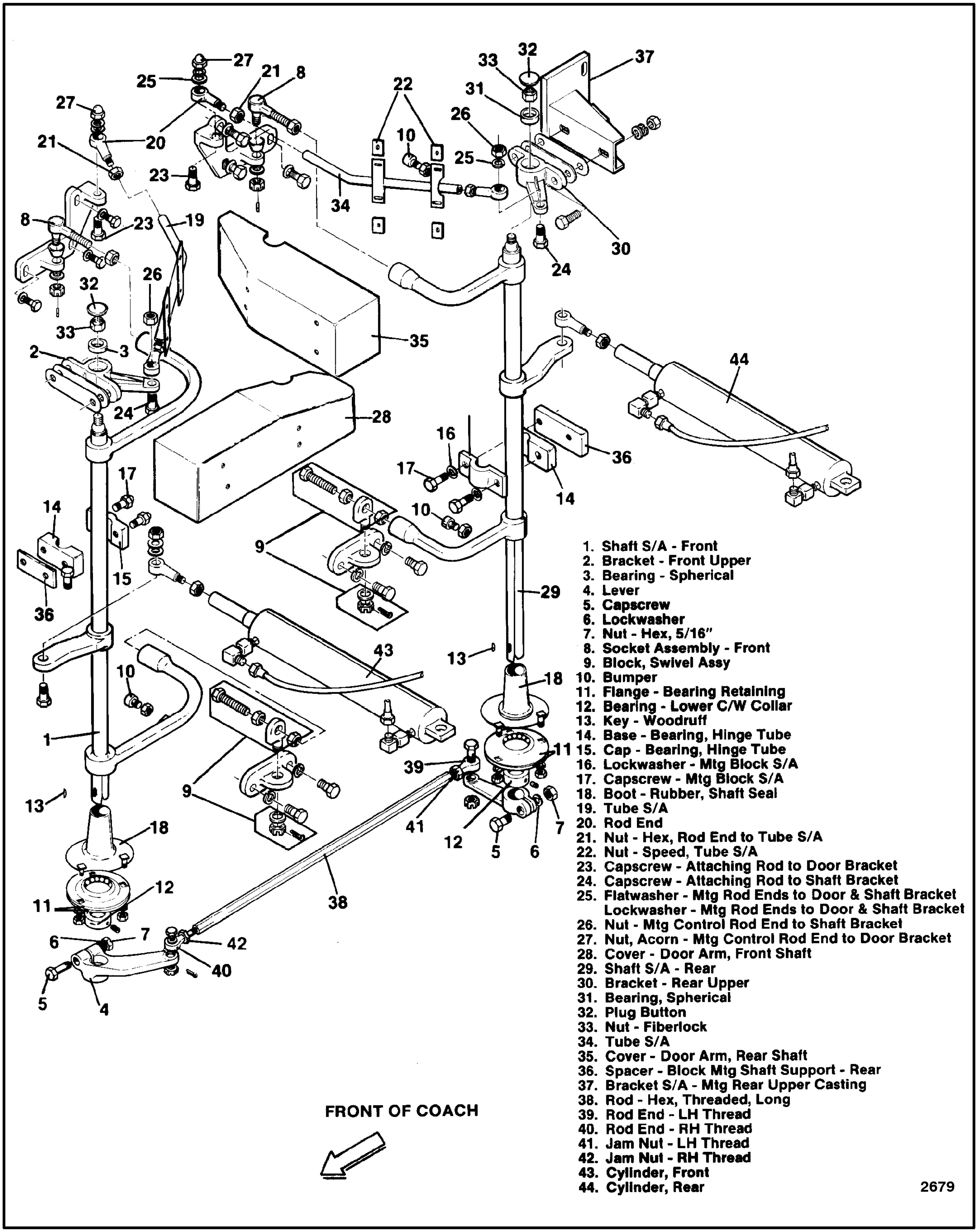
Door Leaf Panels

NOTE: The removal procedure may require two technicians.

1. Turn battery disconnect switch to “OFF” position,
2. Actuate the entrance door switch to open doors, and dump all air via the manual override dump valve.
3. Unfasten and remove the top shaft arm covers (Figure 22).
4. Unfasten the upper front and rear door leaf panel-to-shaft arm mounting bracket capscrews.
5. Unfasten the lower door leaf panel-to-shaft arm mounting bracket capscrews and remove the doors.

Door Control Mechanism

1. Turn battery disconnect switch to “OFF” position,
2. Actuate the entrance door switch to open doors, and dump all air via the manual override dump valve.
3. Unfasten and remove the air cylinder access panels.
4. Unfasten and remove the bearing box access panel.
5. Unfasten and remove the front and rear control arm clamp bolt and remove clamps and control arm assembly from the shafts.
6. Unfasten stop collar set-screws and remove collars from bottom of shafts.
7. Unfasten and remove bottom bearing assemblies from bearing box studs, and slide rubber boot off shafts.
8. Unfasten top shaft locknut retaining the upper shaft bearing block.
9. Unfasten and remove the upper stabilizer tube assemblies from upper shaft bearing block mounting arm. Then unfasten and remove the upper bearing block.
10. Unfasten and remove the lower bearing block from shafts.
11. Rotate shafts to the air cylinder extend positions, and unfasten cylinder rod ends from shaft arms.
12. Lift shafts with brackets out of bottom bearing assemblies and remove for disassembly.
13. Tag and disconnect all air line to the air cylinders.
14. Unfasten and remove the air cylinders from their mountings.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4
FRONT OF COACH
2679

1. Shaft S/A - Front
2. Bracket - Front Upper
3. Bearing - Spherical
4. Lever
5. Capscrew
6. Lockwasher
7. Nut - Hex, 5/16"
8. Socket Assembly - Front
9. Block, Swivel Assy
10. Bumper
11. Flange - Bearing Retaining
12. Bearing - Lower C/W Collar
13. Key - Woodruff
14. Base - Bearing, Hinge Tube
15. Cap - Bearing, Hinge Tube
16. Lockwasher - Mtg Block S/A
17. Capscrew - Mtg Block S/A
18. Boot - Rubber, Shaft Seal
19. Tube S/A
20. Rod End
21. Nut - Hex, Rod End to Tube S/A
22. Nut - Speed, Tube S/A
23. Capscrew - Attaching Rod to Door Bracket
24. Capscrew - Attaching Rod to Shaft Bracket
25. Flatwasher - Mtg Rod Ends to Door & Shaft Bracket
    Lockwasher - Mtg Rod Ends to Door & Shaft Bracket
26. Nut - Mtg Control Rod End to Shaft Bracket
27. Nut, Acorn - Mtg Control Rod End to Door Bracket
28. Cover - Door Arm, Front Shaft
29. Shaft S/A - Rear
30. Bracket - Rear Upper
31. Bearing, Spherical
32. Plug Button
33. Nut - Fiberlock
34. Tube S/A
35. Cover - Door Arm, Rear Shaft
36. Spacer - Block Mtg Shaft Support - Rear
37. Bracket S/A - Mtg Rear Upper Casting
38. Rod - Hex, Threaded, Long
39. Rod End - LH Thread
40. Rod End - RH Thread
41. Jam Nut - LH Thread
42. Jam Nut - RH Thread
43. Cylinder, Front
44. Cylinder, Rear

Figure 22. Bi-Parting Door Control Mechanism

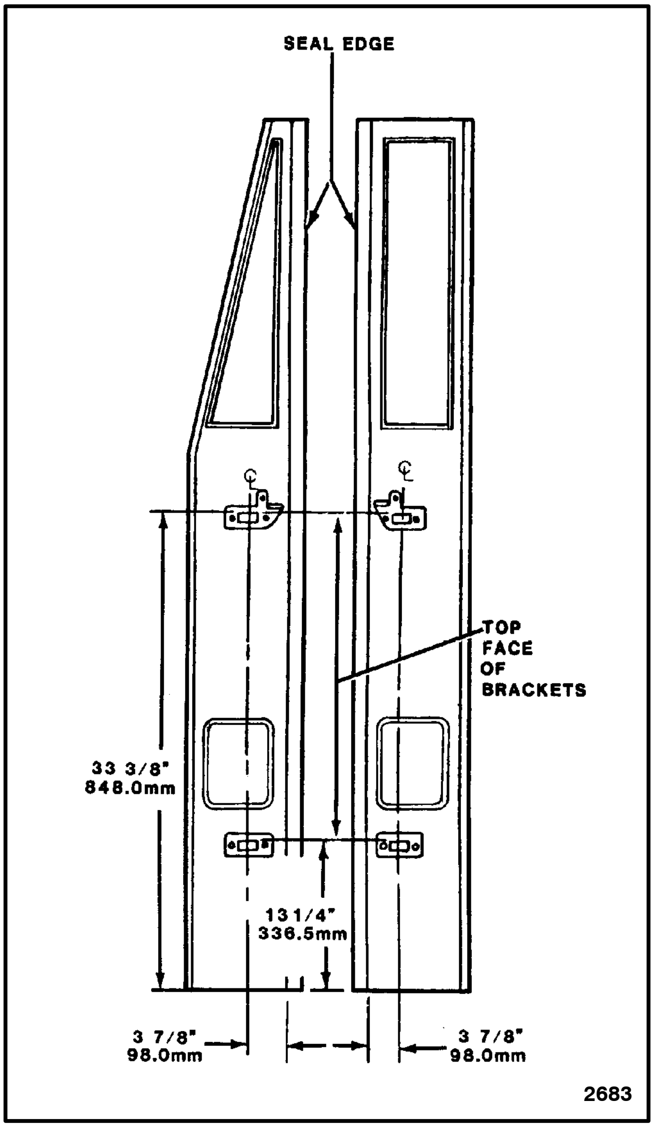

Figure 23. Door Panels

INSTALLATION

1. Reinstall the door controls and door leaf panels in reverse order of the "Removal" procedure. Check all door adjustments after installation is complete.

NOTE: Install air cylinder rod assemblies with lubrication fittings facing stepwell.

Check position of upper and lower hanger brackets on each door leaf. Ensure that brackets are positioned in accordance with dimensions shown (Figure 23).

OPERATIONAL CHECK

1. Move both door panels manually through full open and closed positions. Check for interference between front door panel and body panels, right-hand exterior rear view mirror, etc.
2. Move door panels to closed position. Check for door to body clearances.
3. Place battery switch in "ON" position. Place manual air valve at driver's position to air "ON" position.
4. Check both the interior and exterior operator's door control switch to cycle door from both positions.

NOTE: To check door operation, coach air system should have a minimum of 85 psi (586 kPa).

5. With air "ON" and door closed, check for the following:

A. A proper seal takes place between both door panels.

B. Clearance between doors and body should be 1/4 inch (6.35 mm) minimum from top to bottom. At top of doors, clearance should be 1/8 inch (3.17 mm). If these clearances are not correct, refer to the "Troubleshooting" portion of this information for corrective procedures.

C. Inner feather body seal fits snug to sides and top of doors.

D. Check contour of doors with contour of body. Door panels should follow contour of body from top to bottom.

TROUBLESHOOTING

DOOR PANEL TOO HIGH OR TOO LOW

A. Loosen capscrews in both upper and lower hanger brackets.

B. Move door panel up or down as required.

C. Tighten capscrew in brackets.

DOOR PANEL ON ANGLE

A. Loosen capscrews in top or bottom bracket.

B. Move door panel in direction required to correct clearance between door and body.

DOOR CONTROL ARMS BINDING

The center of the door control arms should be free to move up and down slightly with the doors fully closed. If any are tight, release air from the door system with the air dump valve next to the driver's area, disconnect one rod end from the end of the tight arm(s), close doors manually, and reapply air. Note that doors should be in the closed position during this adjustment. Adjust rod end until it can be easily reinstalled. Replace and tighten nut.

6. It further adjustments are required to door panels, refer to the following procedures:

INSUFFICIENT TRAVEL OF SHAFT AND ARM

A. Loosen jamnuts on master cylinder linkage rod.

B. Turn rod required number of turns to increase length of rod.

C. Tighten jamnuts.

TOO MUCH TRAVEL OF SHAFT AND ARM

A. Loosen jamnuts on master cylinder linkage rod.

B. Turn rod required number of turns to decrease length of rod.

C. Tighten jamnuts.

INSUFFICIENT TENSION AT THE TOP OF THE DOOR

Loosen the locknut at the outer end of the lower arm and screw bolt out until pressure is equalized from top to bottom. Retighten the locknut.

INSUFFICIENT TENSION AT THE BOTTOM OF THE DOOR

Proceed as above except screw the bolt in.

RETRACTABLE ENTRANCE STEP

GENERAL DESCRIPTION

The air operated retractable step feature permits easier passenger boarding by providing an additional extending step assembly. The step extends out below the coach stepwell at an approximately 8-1/2 inches (216 mm) above ground level (Figure 24). The retractable step is controlled by the switch located on the driver's RH switch panel and by an exterior switch in the exterior pocket adjacent to the entrance door switch. The retractable step is controlled by the switch located on the driver's RH switch panel and by an exterior switch in the exterior pocket adjacent to the entrance door switch.

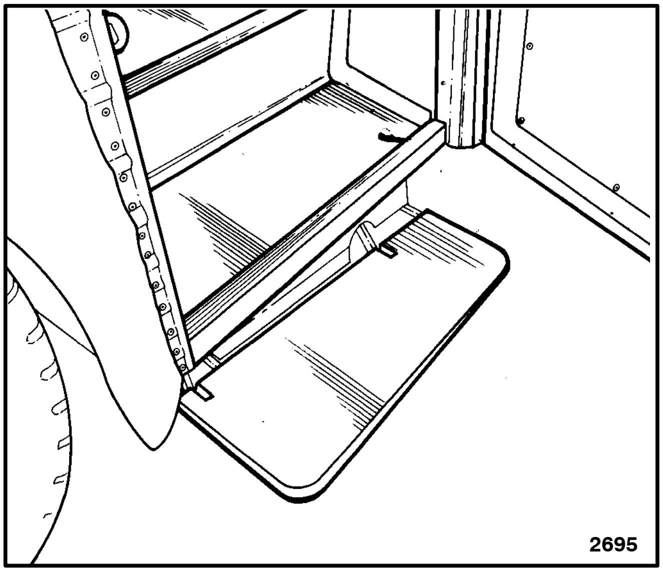

Figure 24. Retractable Entrance Step

COMPONENTS

The retractable step feature consists of a step frame assembly, an electrical and air control valve assembly, extending and locking cylinders and actuation switches (Figure 25).

STEP FRAME ASSEMBLY

The step frame assembly is mounted to coach frame beneath the entrance door bearing box. The structure consists of four pivot arms and the extending step. The step is covered with a cautionary rubber tread. The step frame assembly is protected by a heavy steel guard mounted to coach frame in front of the structure.

EXTEND AND LOCK CYLINDERS

The double-acting step extend/retract cylinder's rod end is connected to the structure and to the coach frame bracket at the other end. The single acting spring returned locking cylinder is mounted to the structure and it rod end is fitted with a indexing pin that prevents step movement during travel. All cylinder air lines are connected to the step control manifold.

CONTROL VALVE MANIFOLD

The Airdraulics step control valve manifold controls the extend and locking air cylinders. The manifold is fitted with three pressure switches, two solenoid stop valves and two Clippard directional air valves. The manifold is located inside the pocket below the passenger modesty panel adjacent to the door locking claw. The step control incorporates a Norgren air filter installed upstream from the valve.

SWITCHES

The interior and exterior momentary-on type step switches control extend/retract functions of the retractable step. The interior switch is located on the driver's RH switch panel. The exterior switch is located in the exterior pocket adjacent to the entrance door switch (Figure 26).

OPERATION

The two modes of step operation are extend and retract. The operation of the retractable step functions can not occur until at least 100 psi air pressure is present, with the park brake applied and micro-switch closed. The "STEP-OUT" tell-tale lamp should illuminate during the extend mode.

NOTE: Tell-tale lamp ground circuit is provided through the PS-1 pressure switch, which is closed when exhaust port is pressurized.

Extend

When the retractable step switch is positioned to "STEP OUT", the entrance step's air control manifold solenoid B is energized via ground circuit of the step switch through the retract relay and PS-3 pressure switch. Solenoid B opens the manifold air passages to the locking and step air valves. The air valves direct the flow of air to the locking and step cylinders. The step valve also allows for the exhausting of the retract side of step cylinder. From the air valves supply air is routed to the extend side of the step cylinder and to the locking cylinder, which retracts and unlocks the step from the stow position.

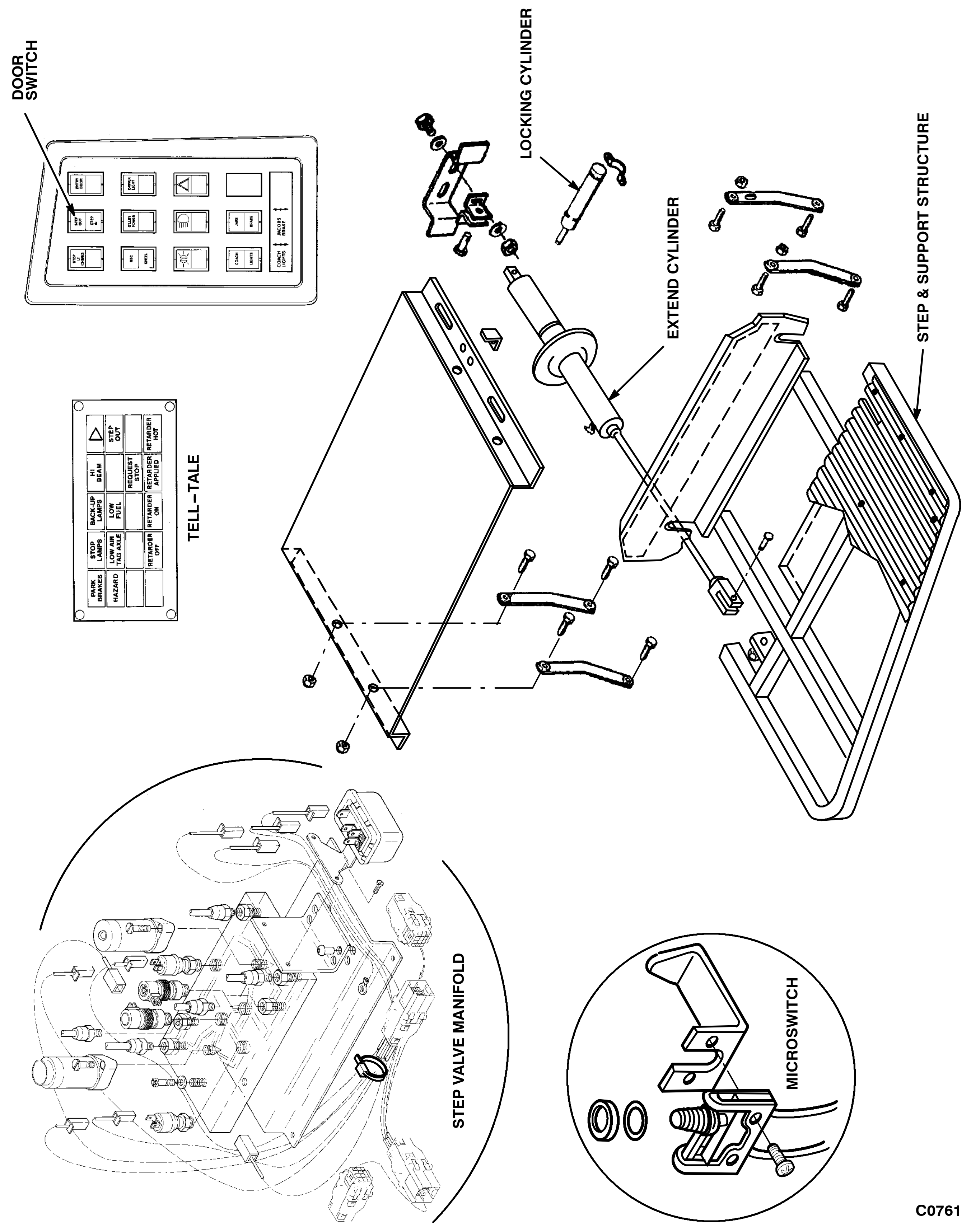
DOOR SWITCH
LOCKING CYLINDER
EXTEND CYLINDER
STEP & SUPPORT STRUCTURE
TELL-TALE
PARK BRAKES
STOP LAMPS
BACK-UP LAMPS
HI BEAM
HAZARD
LOW AIR TAG AXLE
LOW FUEL
STEP OUT
RETARDER OFF
RETARDER ON
REQUEST STOP
RETARDER APPLIED
RETARDER HOT
STEP VALVE MANIFOLD
MICROSWITCH
C0761

Figure 25. Retractable Step Components

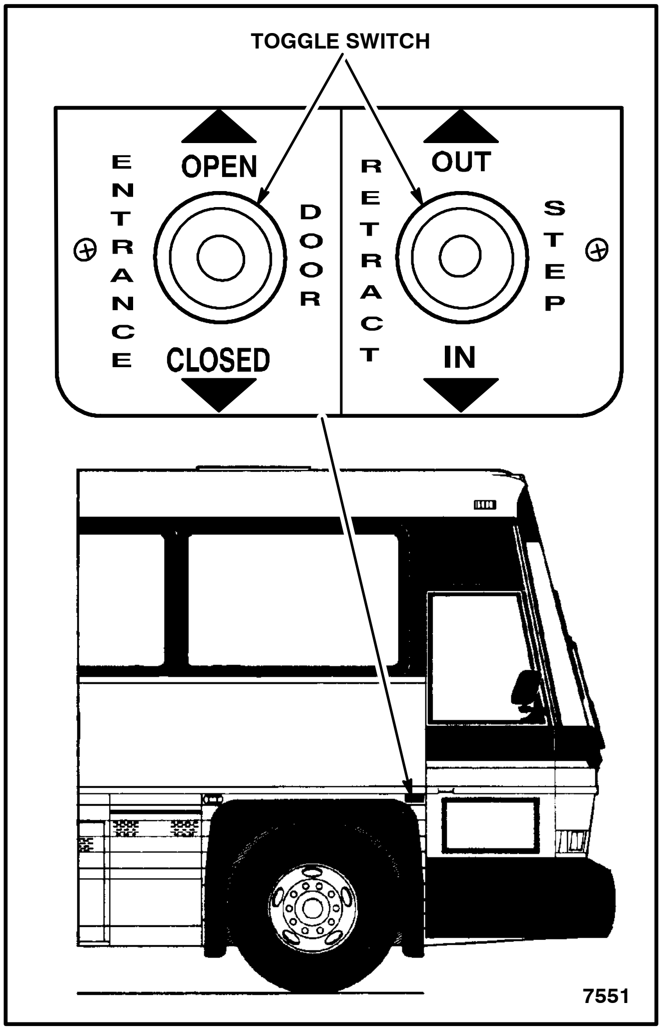

Figure 26. External Entrance Door Switch

NOTE: The pressure switch PS-3 is closed at 100 psi.

If a low air condition should occur while the step is extended, the return spring tension of the directional lock valve should overcome air pressure and move the valve to exhaust. When this happens the locking cylinder is exhausted through the manifold 's exhaust port, and the return spring extends the index pin into the locking hole.

Retract (Normal)

When the retractable step switch is repositioned to “STEP IN”, the entrance step’s air control manifold solenoid A is energized via ground circuit of the step switch through the retract relay and PS-3 pressure switch. Solenoid A opens the other manifold air passages to the locking and step air valves. The valve’s directional vanes are repositioned to exhaust the locking cylinder and the extend port of the step cylinder.

NOTE: The step should automatically retract, if driver unintentional releases the park brake for travel before retracting the step to its stow position.

Retract (Park Brake Released)

When the park brake is released, the micro-switch opens and the retract relay is de-energized. Solenoid A is now energized through the PS-2 pressure switch ground circuit via the de-energized retract relay and PS-3.

NOTE: Upon engine start-up, it may be necessary to build up coach air pressure to fully retract the entrance step and turn off telltale.

MAINTENANCE

STEP FRAME ASSEMBLY

The step frame has no maintenance requirements of the than periodic inspection of fasteners and adjustment of locking cylinder and skid plate.

Removal

1. Move battery disconnect switch to the “OFF” position, and vent air system.
2. Tag and disconnect all air lines to step and locking cylinders.
3. Unfasten and remove the step cylinder from the step frame mounting bracket.
4. Unfasten and remove the locking cylinder from the step frame mounting bracket.
5. Unfasten and remove capscrews mounting step to the coach frame.
6. Remove step frame structure from the coach.

Installation

1. Reinstall in reverse order of the “Removal” procedure.

CONTROL VALVE MANIFOLD

There is no specific maintenance requirements for the manifold, however, all of the manifold components may be replaced. The air filter element should be cleaned and/or replaced every 100,000 miles (160,00 km).

Solenoid Replacement

1. Move battery disconnect switch to the “OFF” position.
2. Remove panel from rear wall of stepwell to gain access to manifold.
3. Disconnect wire harness from solenoid and gently bend the terminal up to clear adjacent components.
4. Insert small spanner rod into hole at base of solenoid and turn counter-clockwise to remove.

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5. Install new solenoid and snug hand tight. Reconnect harness and test step function.

Directional Valve Replacement

1. Follow steps 1 and 2 of previous replacement procedure.

2. Unfasten two mounting screws and remove valve from manifold.

3. Install new valve, refasten mounting screws and test step function.

Pressure Switch Replacement

1. Follow steps 1 and 2 of previous replacement procedure.

2. Disconnect wire harness from pressure switch.

3. Unfasten and remove old pressure switch.

4. Install new switch and snug hand tight. Reconnect harness and test step function.

Removal

1. Move battery disconnect switch to the “OFF” position, and vent air system.

2. Remove panel from rear wall of stepwell to gain access to manifold.

3. Tag and disconnect all wire harnesses from manifold assembly.

4. Tag and disconnect all air lines to and from manifold assembly.

5. Unfasten and remove manifold from mounting bracket.

Installation

1. Reinstall in reverse order of the “Removal” procedure.

AIR CYLINDERS

The retractable step and locking air cylinders should be lubricated through air hose connector at approximately 50,000 miles (80,000 km) intervals. Lubricate with specification S-6 (Heavy-Duty Engine Oil - 10W).

Removal

LOCKING CYLINDER

The retractable step locking air cylinder is located on the bracket attached to the step frame front.

1. Move battery disconnect switch to the “OFF” position, and vent air system.

2. Disconnect the air tubing attached to cylinder.

3. Unfasten capscrew mounting cylinder bracket to step frame.

4. Disassemble cylinder from mount bracket.

STEP CYLINDER

The retract/extend step cylinder is located behind the and to the rear of the step frame.

1. Move battery disconnect switch to the “OFF” position, and vent air system.

2. Disconnect the air tubing attached to cylinder extend/retract ports.

3. Unfasten and remove the step cylinder’s rod end from the step frame mounting lug.

4. Unfasten and remove the step cylinder from rear front frame mounting bracket.

Installation

1. Reinstall cylinders in reverse order of the “Removal” procedure.

SPECIFICATIONS

SEDAN DOOR CONTROL ASSEMBLY

Manufacturer	MCI
Part Number	3L-10-210

SEDAN DOOR ACTUATING CYLINDER

Manufacturer	Bimba
Part Number	3L-10-206

SEDAN DOOR LOCKING CYLINDERS

Manufacturer	Clippard
Part Number (Header)	3L-10-196
Part Number (Claw)	3G-10-5

BI-PARTING DOOR CONTROL ASSEMBLY

Manufacturer	Humphrey
Part Number (Valve)	4B-21-1
Part Number (Front Shaft)	3L-32-636
Part Number (Rear Shaft)	3L-32-637

BI-PARTING DOOR ACTUATING CYLINDERS

Manufacturer	Bimba
Part Number	3L-10-231

RETRACTABLE STEP CONTROL ASSEMBLY

Manufacturer	Airdraulic
Part Number	4L-22-128

RETRACTABLE STEP ACTUATING CYLINDER

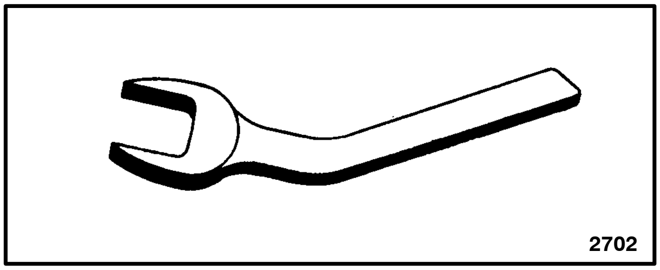
Manufacturer	Clippard
Part Number	4L-22-222

RETRACTABLE STEP LOCKING CYLINDER

Manufacturer	Airdraulic
Part Number	4J-22-22

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20 – Entrance Door Linkage Wrench.

SECTION 3D2

BAGGAGE AND SERVICE COMPARTMENT DOORS AND ESCAPE HATCHES

CONTENTS OF THIS SECTION

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Baggage and Service Compartment Doors 3D2-1
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  Components 3D2-1
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Emergency Escape Hatches 3D2-5
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Specifications 3D2-6
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BAGGAGE AND SERVICE COMPARTMENT DOORS

GENERAL DESCRIPTION

The D series coaches are constructed with three baggage bays, numerous service compartments and two roof escape hatches. All baggage bay doors, service compartment doors and emergency exit ways are secured by hinged doors or access covers.

All doors are fitted with either black rubber or anodized aluminum rub rail assemblies. Optional keyed alike locks are available on selected baggage and service doors. Optional air-operated or electrically actuated baggage door locking systems are also offered that automatically lock with release of the parking brake.

COMPONENTS

FRONT SIDE SERVICE DOOR

A left front side service door below the electrical junction box service door is front-hinged, held closed by two quarter-turn Dzus fasteners. Access is provided to the front bumper release handle, accessory air reservoir, emergency fill valves, steering components, windshield washer and horns.

CONDENSER COMPARTMENT DOOR

The condenser compartment door is located to the rear of the #2 LH baggage door. The door is fitted with a piano type front hinge, and held closed by quarter-turn Dzus fasteners. A rod type prop automatically holds the condenser door when fully opened. Access is provided to condenser fan and motor, receiver tank, inspection panels and other air conditioning components.

BATTERY COMPARTMENT DOOR

The battery compartment door is top-hinged and held closed by a flush-mounted paddle handle latch. A prop rod holds the door open while providing access to batteries, air conditioning filter and battery disconnect switch. This door is fitted with a small hinged door for quick access to the disconnect switch.

FRONT JUNCTION BOX DOOR

The electrical junction panel service door is located below the driver's window. The door is fitted with a piano type front hinge and held closed by two quarter-turn Dzus fasteners. A prop rod holds the door open. This door provides access to the audio amplifiers, auxiliary overrule knob, various circuit breakers and relays, warning buzzer and speed switch.

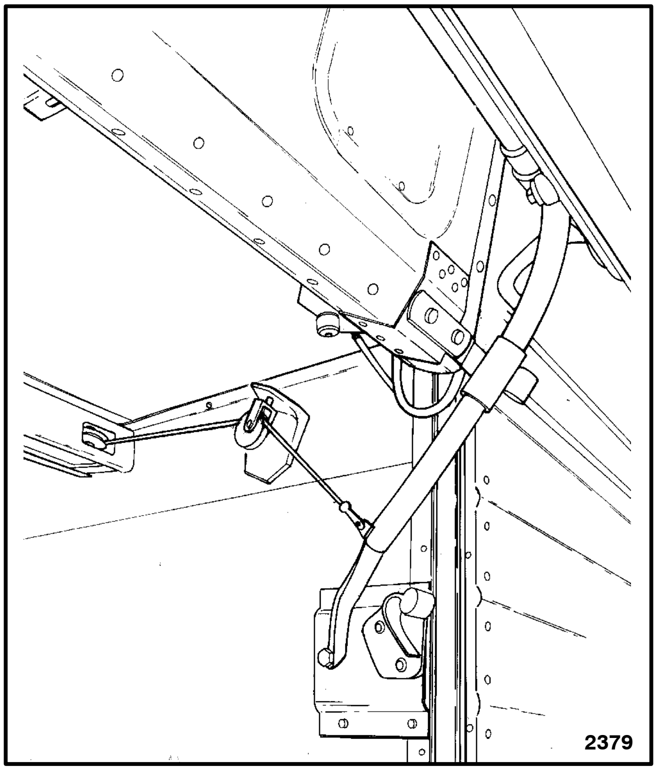


Figure 1. Baggage Door Hinge and Cable

ENGINE SERVICE DOORS

The rear engine compartment service doors are side hinged. A flush-mounted paddle handle latch is installed on right door which overlaps the edge of the left door. Prop rods are provided on both doors to hold the open position.

REAR SIDE SERVICE DOORS

The engine compartment is accessible through LH/RH rear side service doors. The doors are front-hinged and held closed by a flush-mounted paddle handle latch, a prop rod holds the doors in the open position.

RADIATOR COMPARTMENT DOOR

The radiator compartment door is top-hinged and held closed by two spring loaded latches. A prop rod automatically holds door when fully opened. Access is provided to the radiator, air cooler, surge tank, fan belts and fan controls.

FUEL TANK FILLER DOOR

The fuel tank small fill access is a side hinged spring assisted door. The main fuel door panel is retained at the top by two bolts and at the bottom by pins, for access to the fuel tank assembly and drain plug if removal is necessary.

AIR CLEANER SERVICE DOOR

The air cleaner is accessible through the service door mounting the LH back-up light. The door is side-hinged and held closed by two quarter-turn Dzus fasteners. A rod type prop automatically holds the door when fully open.

A/C COMPRESSOR SERVICE DOOR

The air conditioner compressor is accessible through the service door mounting the RH back-up light. The door is side-hinged and held closed by two quarter-turn Dzus fasteners. A rod type prop holds the door open.

BAGGAGE COMPARTMENT DOORS

Baggage compartment doors have a clear 33” x 54” (840 mm x 1380 mm) opening provided to each compartment on both sides of the coach. All compartment doors are fully sealed, Pantograph, vertical lift type, and each has a flush-mounted breakaway-type, safety hold-open catch with provision for padlock and customs seals (Figure 1). All doors are interchangeable. Doors are counterbalanced with springs for ease of operation. To open, insert fingers under latch, then pull outward and up. To close, hold latch in open position, pull downward on door and push down on latch to secure door. Rubber bumpers prevent the door from contacting the body when opened.

NOTE: 102D3 coaches have a slightly smaller door securing baggage bay #3.

AIR-OPERATED LOCKING SYSTEM

The air-operated locks are applied by spring pressure of the single acting air cylinder mounted on each door, and require air pressure to be release. To unlock the baggage doors, the parking brake must first be applied. Actuation of the control knobs below the entrance door overrule valve will lock or unlock. When the coach air system drops to approximately 60 psi, the air operated baggage doors will lock and can only be released when the coach air pressure is returned to normal. The emergency air fill provision would permit operation of air cylinder to open doors in emergencies (Figure 2).

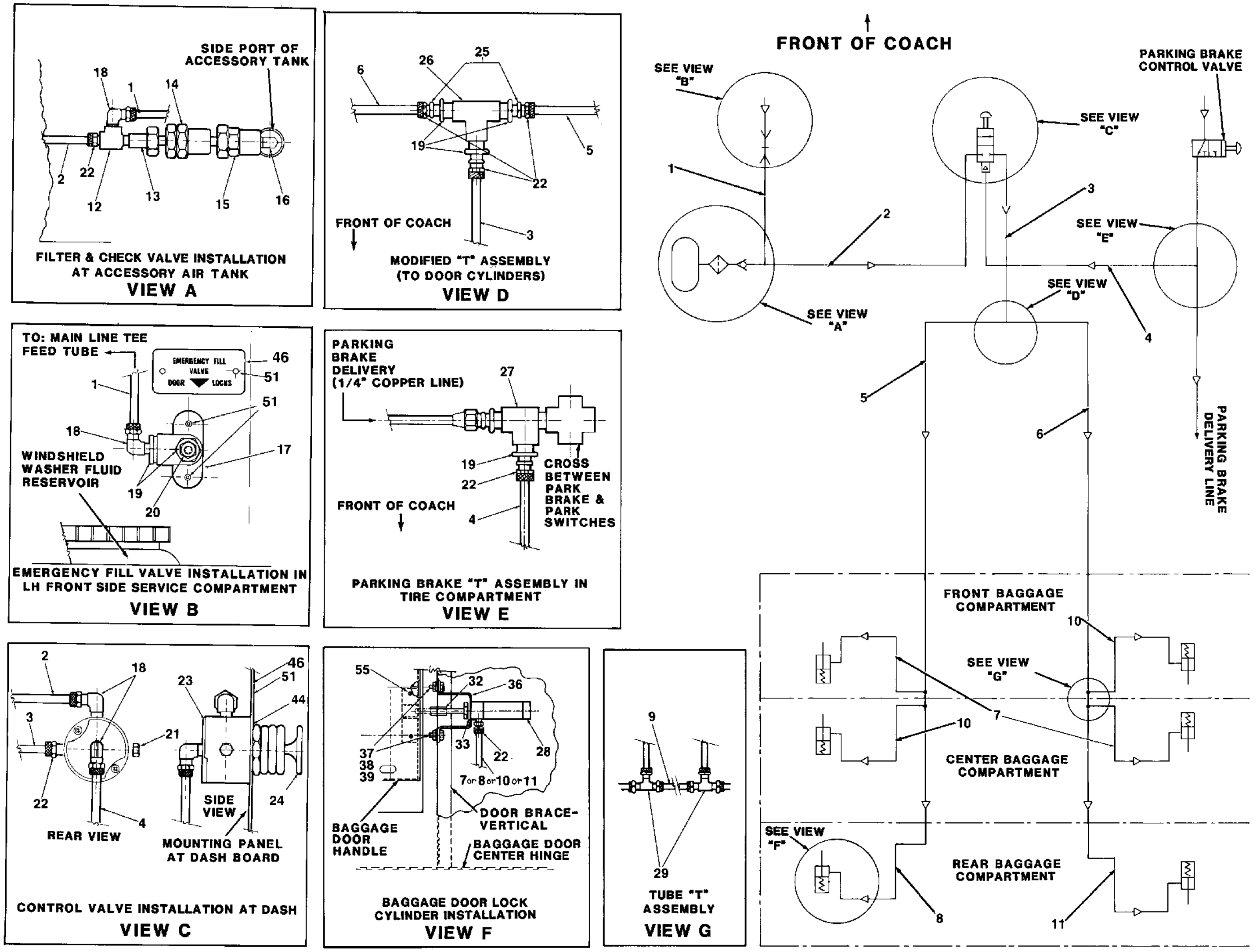
MAINTENANCE

ADJUSTMENT

When adjusting baggage doors for proper locking and/or sealing, always check that the handle and locking rod mechanism is adjusted for maximum contact with locking lugs and/or catches.

1. Remove cotter pin (on inside of operating latch) retaining the yoke pivot pin (Figure 3).

2. Slide out yoke pivot pin. Loosen jamnut and turn threaded yoke to desired length.


FRONT OF COACH
SEE VIEW "B"
SEE VIEW "C"
PARKING BRAKE CONTROL VALVE
SEE VIEW "E"
SEE VIEW "D"
SEE VIEW "A"
PARKING BRAKE DELIVERY LINE
FRONT BAGGAGE COMPARTMENT
SEE VIEW "G"
CENTER BAGGAGE COMPARTMENT
SEE VIEW "F"
REAR BAGGAGE COMPARTMENT
1
2
3
4
5
6
7
8
10
11
SIDE PORT OF ACCESSORY TANK
FILTER & CHECK VALVE INSTALLATION AT ACCESSORY AIR TANK
VIEW A
FRONT OF COACH
MODIFIED "T" ASSEMBLY (TO DOOR CYLINDERS)
VIEW D
TO: MAIN LINE TEE FEED TUBE
EMERGENCY FILL VALVE DOOR LOCKS
WINDSHIELD WASHER FLUID RESERVOIR
EMERGENCY FILL VALVE INSTALLATION IN LH FRONT SIDE SERVICE COMPARTMENT
VIEW B
PARKING BRAKE DELIVERY (1/4" COPPER LINE)
CROSS BETWEEN PARK BRAKE & PARK SWITCHES
FRONT OF COACH
PARKING BRAKE "T" ASSEMBLY IN TIRE COMPARTMENT
VIEW E
REAR VIEW
SIDE VIEW
MOUNTING PANEL AT DASH BOARD
CONTROL VALVE INSTALLATION AT DASH
VIEW C
7 or 8 or 10 or 11
DOOR BRACE-VERTICAL
BAGGAGE DOOR CENTER HINGE
BAGGAGE DOOR HANDLE
BAGGAGE DOOR LOCK CYLINDER INSTALLATION
VIEW F
TUBE "T" ASSEMBLY
VIEW G
2665

1. Tubing-Accessory Air Tank to Emergency Fill Valve
2. Tubing-Accessory Air Tank to Door Valve Supply
3. Tubing-Door Valve Delivery Port to Door Cylinder Tee
4. Tubing-Door Valve Exhaust Port to Park Brake Valve
5. Tubing-Door Cylinder Tee to L.H. Interior Tee
6. Tubing-Door Cylinder Tee to R.H. Interior Tee
7. Tubing-R.H. Center Door Cylinder to Interior Tee; also L.H. Front Door Cylinder to Interior Tee
8. Tubing-L.H. Rear Door Cylinder to Interior Tee
9. Tubing-Interior Tee to Interior Tee (2 Places)
10. Tubing-L.H. Center Door Cylinder to Interior Tee; also R.H. Front Door Cylinder to Interior Tee
11. Tubing-R.H. Rear Door Cylinder to Interior Tee
12. Street Tee-1/8"NPT Brass
13. Reducer Coupling-1/4"Pipe X 1/8"Pipe Brass
14. Check Valve
15. Air Filter
16. Elbow-1/4" NPT Steel
17. Drop Elbow
18. Elbow-1/4"Tube X 1/8"NPT Brass
19. Reducer Bushing-1/4"NPT X 1/8"NPT Female
20. Valve
21. Plug-1/8"NPT Brass
22. Male Connector-1/4"Tube X 1/8" NPT Brass
23. Valve
24. Button
25. Restrictor Jet-.046 Orifice
26. Tee-1/4"NPT Brass
27. Street Tee-1/4" NPT Brass
28. Air Cylinder
29. Union Tee-1/4" Tube Brass
30. Plunger
31. Lockwasher-5/8"
32. Clamp-3/8"
33. Clamp-1/4"
34. Air Cylinder Mounting Bracket
35. Capscrew-1/4-20 UNC X 3/4"
36. Nut-1/4-20 UNC
37. Lockwasher-1/4"
38. Tapping Screw-#8-32 UNC X 1/2"
39. Machine Screw-#8-32 X 3/4"
40. Machine Screw-#8-32X1/2"
41. Hex Nut-#8-32 UNC
42. Lockwasher-#8
43. Reinforcing Hat Channel
44. Backing Washer
45. Nameplate-"Baggage Door Lock-Push to Open"
46. Nameplate-"Emergency Fill Valve-Door Locks"
47. Rivet-1/8"
48. Grommet-1/4' I.D. X 3/32" Groove
49. Tyrap
50. Loom-5/16" I.D.
51. Rivet-3/16" Stainless Steel
52. Lockwasher-1/4"
53. Flatwasher-1/4"
55. Seal

Figure 2. Air-Operated Baggage Door Locking System

3. Tighten jamnut and reassemble in reverse order.

If baggage door locks too tightly and pinches seal at either top or bottom or locks too loosely, adjust the upper or lower catches on the inside edges of the baggage compartment.

4. Loosen retaining capscrews and slide upper or lower catches to desired position and retighten.

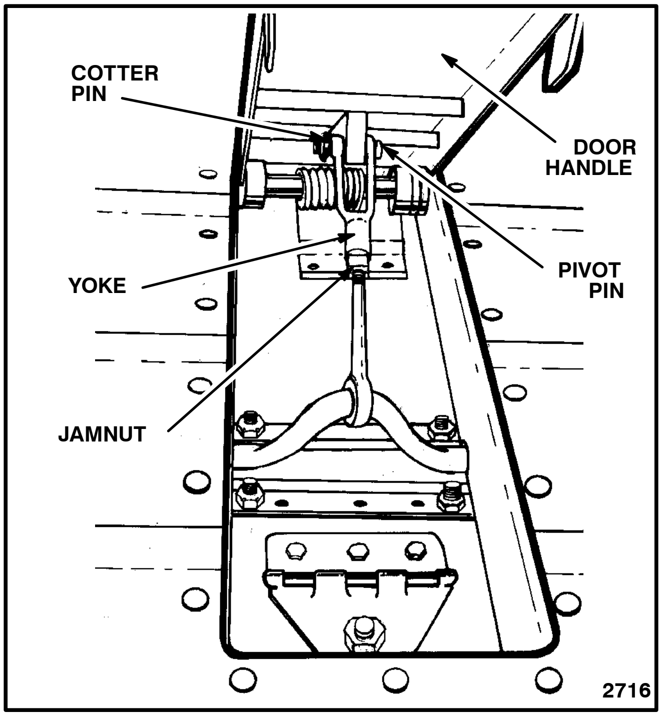


Figure 3. Baggage Door Catch

INSPECTION

1. Inspect the pulley cables for fraying. Replace the cables if necessary.

2. Check the pulleys for wear and cracks. Replace them if either of these conditions exists.

REMOVAL

Baggage Door

NOTE: Baggage door removal should be performed by two persons.

1. Place battery disconnect switch to “OFF” position.

2. Fully open baggage door and support it to prevent falling when cables are removed.

3. Using baggage door cable pulling tool (20-46), pull the cable back to allow removal of the clevis pins that attach the pulley cables to the stabilizer tube (Figure 4)

⚠ WARNING ⚠

The baggage door mechanism’s cable assembly is under tension. Exercise extreme caution during removal and installation.

4. Unfasten and remove the stabilizer tube from mounting brackets.

⚠ WARNING ⚠

Baggage door must be supported at this stage to prevent it from falling during final removal procedures.

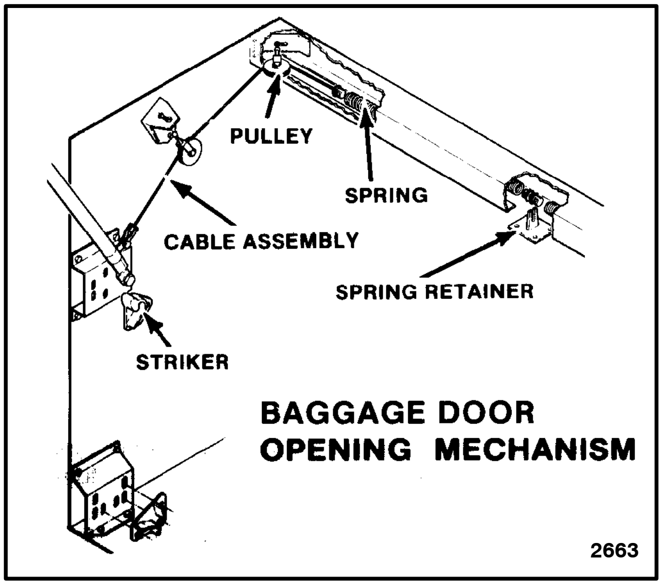


Figure 4. Baggage Door Hold-Open Cable

5. Remove the screws that secure the hinge panel to the coach body and remove door, stabilizer tube and hinge panel as an assembly.

To remove the rest of the cable and spring assembly, follow these additional steps.

6. Remove the cable end/spring plug from the spring by rotating the plug.

7. Remove the four capscrews that mount the spring retainer to the upper compartment ceiling channel.

8. Rotate the spring to remove it from the spring retainer.

Fuel Door

1. Place battery disconnect switch to “OFF” position.

2. Fully open the small filler door to gain access to the main door/panel capscrews.

3. Unfasten and remove capscrews from mounting brackets and remove door.

Hinged Service Doors

1. Place battery disconnect switch to “OFF” position.

2. Fully open door and support it to prevent falling when hinges are removed.

3. Unfasten and remove all prop rods or spring clip assemblies from door.

4. Unfasten and remove all hinge fasteners and remove door from coach.

> **NOTE:** To remove the battery door’s small disconnect switch door, the inner fiberglass panel must be removed to access fasteners.

INSTALLATION

> **NOTE:** Replacement baggage and service compartment doors are provided without rub rail assemblies, keyed locks and air or electric locking systems. Some painted doors with optional aluminum rub rail assemblies will require additional mounting holes.

Baggage Door

1. Reassemble springs and cables, following the above steps in reverse order.

2. Position and support the baggage door in the fully open position, and install door in reverse order of the “Removal” procedure.

Fuel Door

1. Position door/panel pin into frame holes and refasten capscrews.

Hinged Service Doors

1. Position and support the door in the fully open position, and reinstall prop rod, spring clips and hinge fasteners.

EMERGENCY ESCAPE HATCHES

GENERAL DESCRIPTION

Two 20 x 29 inch (51 x 74 cm) escape hatches are located in the roof. The hatches are used for the emergency exiting of the coach (Figure 5).

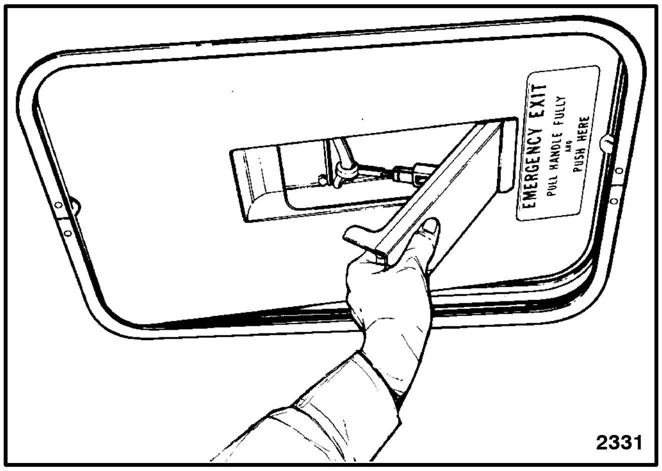


Figure 5. Emergency Escape Hatch.

MAINTENANCE

ADJUSTMENT

The emergency escape hatches in the roof can be checked and adjusted for correct hatch sealing. Open the emergency hatch and examine the surface of the rubber seal surrounding the hatch opening. An impression should be seen in the seal where the hatch has made contact. If the impression shows as a continuous unbroken line, the seal is good and requires no adjustment.

When adjusting escape hatch for proper locking and/or sealing, always check that the handle and locking rod mechanism are adjusted for maximum contact with locking lugs and/or catches.

1. Unfasten catches on both sides of the hatch opening and moving the catches up, down, front or back as required to adjust hatch cover.

> **NOTE:** If additional forward or rearward adjustment is required, it may be necessary to remove the catches and elongate the slotted holes.

2. Close and check the seal to determine if the hatch is centered; readjust if necessary.

NOTE: To obtain a clear impression, it may help to chalk the edge of the lip.

REMOVAL

1. Place battery disconnect switch to "OFF" position.

2. Unfasten hinge mountings and remove access cover.

3. Remove seal material from mount ring trough, and drill out mounting rivets to remove mounting ring.

INSTALLATION

1. Reinstall in reverse order of the "Removal" procedure and adjust closure.

SPECIFICATIONS

BAGGAGE DOOR ASSEMBLY (LARGE 102D3 & 102DL3)

Manufacturer	MCI
Part Number (Basic Painted W/O Keyed Lock)	3L-29-55
Part Number (Basic Stainless W/O Keyed Lock)	3L-29-73

BAGGAGE DOOR ASSEMBLY (SMALL 102D3)

Manufacturer	MCI
Part Number (Basic Painted W/O Keyed Lock)	3L-29-289
Part Number (Basic Stainless W/O Keyed Lock)	3L-29-291

ESCAPE HATCH

Manufacturer	MCI
Part Number	3K-31-8-0002

PADDLE LATCHING HANDLE

Manufacturer	MCI
Part Number (Rear Side Service Doors)	3J-30-45
Part Number (Rear Motor Doors)	3J-30-15
Part Number (Baggage Doors Painted)	3L-29-71
Part Number (Baggage Doors Stainless)	3L-29-87

ELECTRIC SOLENOID LOCK

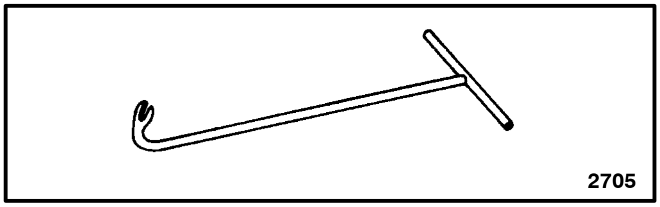
Manufacturer	GM
Part Number	7L-8-959

AIR LOCKING CYLINDER

Manufacturer	Bimba
Part Number	4G-22-55

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



P/N 20-46 Baggage Door Cable Puller

SECTION 3E

WINDSHIELDS, WINDOW SASH & GLAZING

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

The 102 D Series coaches are fitted with extra large LH/RH front windshields for enhanced driver visibility. An additional upper windscreen is installed to mount the larger destination sign assemblies. The driver's side sash and passenger sash are installed along the sidewalls of the coach. Entrance door upper and lower window glazings are also incorporated. Passenger driver's and upper entrance door sash are provided with black anodized aluminum frames. This section will address the proper cleaning and replacement of these items.

COMPONENTS

WINDSHIELD

The LH/RH plain windshield halves are identical and can be used for either side, however, the tinted glass must be ordered for the correct side. The windshield and upper windscreen glass are laced to a flange around the openings by means of a one-piece black rubber extrusion and rubber locking strips.

DRIVER'S WINDOW

The driver's double or single-glazed side window is mounted to the sidewall opening by an inner retaining frame. This window incorporates either a small or large slider-type window section at the lower front corner for tolls, signaling or mirror adjustment (Figure 1)

ENTRANCE DOOR SASH & TRANSOM

The entrance door double or single-glazed upper sash is mounted to the upper door panel by an inner retaining frame. The door panel also has a lower Lucite glazing which resists scratches. An upper transom window is fitted above the door.

PASSENGER SASH

The passenger double or single-glazed side sash AS-3 laminated float safety glass assemblies incorporate a hinged egress frame and glazing, which can be opened by release bars in emergencies. The hinged windows are attached to the outer mounting frame and mounted in the sidewall opening by an inner retaining frame arrangement.

NOTE: Emergency operating instructions on metal plates are attached to the release bars at each seat location.

MAINTENANCE

CLEANING

Wash and rinse water of recirculating auto-washing systems should be free of solids, properly designed, maintained and monitored for efficiency. In all cases suppliers of recirculating auto-washing systems should provide assurance that their equipment and techniques will function satisfactorily with Lucite SAR type windows.

NOTE: Passenger side sash glazings may be manufactured of 1/2 inch thick Lucite SAR material. Special cleaning procedures are required when this material is used.

Brush pressure and amount of filament in contact with the coach are the two factors most damaging to windows of Lucite SAR surfaces. Normally, the amount of filament in contact with the window and brush pressure are directly proportional to one another. As brush pressure is lowered, the amount of filament in contact with the window is less. Total pressure should be as low as possible. The bus should never be stopped while in contact with the brushes.

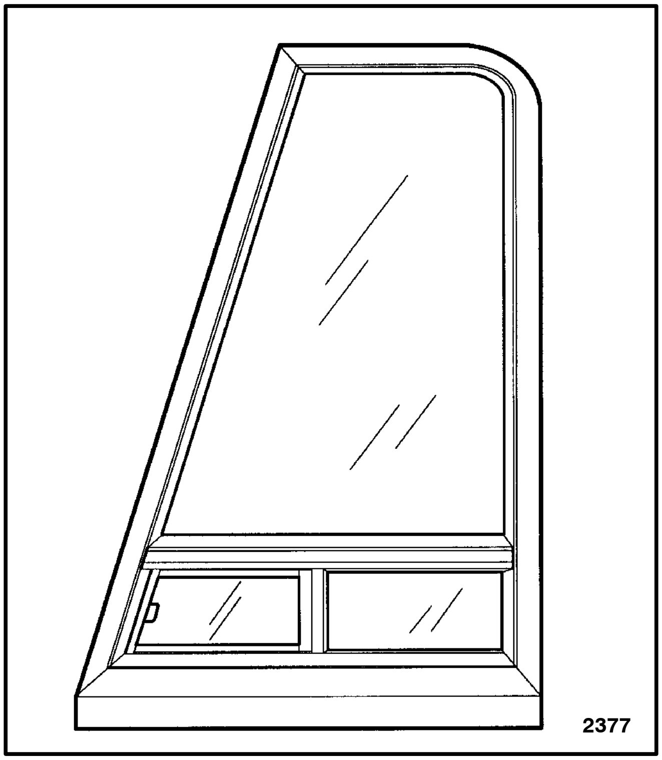


Figure 1. Driver's Window

Conventional techniques may be used to clean Lucite SAR. However, care should be taken to use a clean, soft (unsized) cloth. The surface of the window should be wetted with the cleaning solution before wiping. When oily surface contamination is present, the cleaning solution may not wet the surface thoroughly until it is rubbed with the cloth.

NOTE: The less filament in contact with Lucite SAR, during brush wash will guard against scratches during cleaning. It may be necessary to provide a soft roller or wheel guide on the brush arm to prevent over-pressure of brush.

Household cleaners which have been tested and found effective in cleaning Lucite SAR include Easy-Off, Windex, Glass Plus, Top Job, Mr Clean and Fantastik. Industrial cleaners effective on the acrylic windows are Neleco Subway Soil Solvent (Neleco Products, Inc.) and C-1102 Alkaline Cleaner (DuBois Chemicals).

To remove paint, ink marks and graffiti which are resistant to household cleaners, use a soft cloth saturated with isopropanol or an aliphatic hydrocarbon solvent. Do not use abrasive cleaners. Avoid using razor blades or other sharp instruments which might gouge the surface.

Two commercially available antistatic cleaners which effectively clean Lucite SAR windows and reduce the tendency for static charge build-up are "Like-Magic" Type N1-5, Merchandise Presentations, Inc., 3960 Merritt Avenue, New York, NY, 10466 and "Trend" Antistat Cleaner, Dawn Products, P.O. Box 24, Englewood, CO, 80110. Follow the manufacturers' instructions when using the antistatic cleaners.

REPLACEMENT

WINDSHIELD

Proper installation of the windshield is necessary to reduce or prevent stress during coach operation. Since glass from manufacturer to manufacturer may vary in fit (size and shape), windshields from a source other than MCI should be checked for proper size and curvature using the "Inspection Procedure" steps. Read the entire procedure before starting.

NOTE: The tear-resistant windshield rubber seal (fence) allows for a maximum 5/16" difference in windshield curvature.

⚠ **WARNING** ⚠

Windshield removal and installation must be performed by more than one person. To avoid personal injury, wear protective gloves when handling the windshield glass and windscreen (destination sign) glass.

1. Remove the windshield wiper arm(s) and blade(s).
2. Remove the fascia molding to expose the lower windshield rubber seal.
3. Remove the rubber locking strips from the bottom, side, center post and across the top of the windshield.

NOTE: Locking strips need to be removed from only around the windshield, unless there have been repeated problems with stress cracking the windshield(s). Then both the right-hand and left-hand windshields and the destination sign window must be removed.

4. From inside the coach, one person should push out at the top of the windshield, until clear of the seal. A person on the outside then lifts the windshield up and out of the bottom of the windshield seal.
5. If collision damage has occurred, remove the seal and make an inspection. Gently clean and inspect all surfaces of the opening before reinstalling the rubber seal material.

NOTE: Before proceeding with the installation of a new windshield glass, especially after any front end collision has occurred, it is recommended that the "Inspection Procedure" be reviewed. If the opening(s) have at least a 3/8-inch gap all around square with the glass edges, and the bow of the post is the same as the new glass's curve as checked, then proceed.

6. Soak rubber seal (fence) in warn soapy water, and reinstall into the opening.

7. When driving the rubber onto the center post, support the post from the opposite side to prevent changing the shape of the post.

8. Be sure the rubber seats onto the center post. All the grooves should be seated in the U-channel.

9. Using a liquid lanolin hand soap, lubricate the groove that glass sits in and install the glass into the rubber seal.

10. Carefully place the glass (bottom first) back into the rubber seal groove. With the windshield installed, check to see if the lacing tool will slide through the lacing channel. If the lacing tool binds, shift the windshield until it doesn't bind.

NOTE: Do not use glass slip. Glass slip will swell and soften windshield rubber. Place 2-inch pieces of locking strip in the bottom center and both bottom corners. Place 2-inch pieces in the center of both sides. These strips will keep the glass centered as it is installed.

11. Lubricate the groove the locking strip sits in to help the lacing tool move through the groove. Ensure that you do not stretch the locking strip.

NOTE: In some extreme cases, the upper windscreen (destination sign) glass may need to be removed in order for the windshield to be properly reinstalled. If binding should occur in the top LH/RH corners of windshield glass at installation, grind the bottom of the windscreen glass to allow for needed clearance between the sign window and the windshield. This should remove any stress or extra pressure on the windshield glass.

WINDSCREEN

1. When required, removal of the destination sign windscreen can be achieved by removing locking strip from top edge and sides of the rubber seal. Pry windscreen out at top using nylon tool.

2. Reinstall the destination sign window and lace in the locking strip.

NOTE: There may be some variation in destination sign replacement windows. If the destination sign window does not fit the upper rubber, you may have to lay a shim in the lower groove and then reinstall the window. This will cause the sign window to move upward and engage the upper rubber for a better fit.

INSPECTION

The following procedure has been provided to check windshield glass, windshield openings and center post for proper curvatures.

1. Place 3/8-inch spacers (rubber or wood) in the bottom of the windshield opening.

2. Place windshield in the opening. There should be a 3/8-inch gap all the way around, between the windshield and the body channel. The glass must be square in the opening. If there is not a 3/8-inch space around the glass, remove material from the body flange to obtain the proper clearance. If the glass is not square in the opening, place the other glass in its opening to be sure the openings have the same degree of distortion.

3. The center post should have the same bow as the curvature of the glass. This can be checked by carefully placing the glass (center post edge down) on a piece of cardboard. With a chalk line, strike a line across from edge to edge on the cardboard. At the mid-point, measure the distance from the line to the glass (Figure 2). Both windshields should have the same bow.

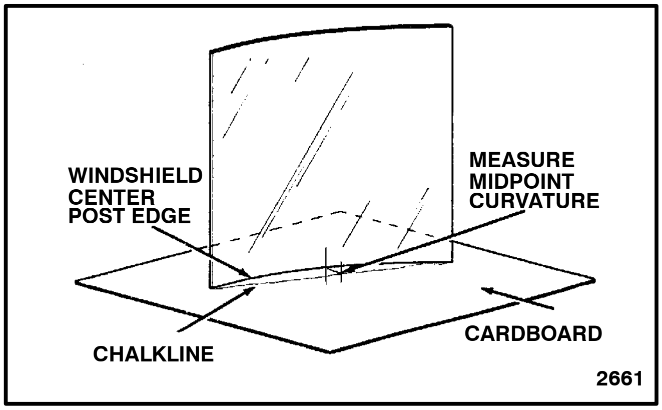


Figure 2. Checking Windshield Curvature

4. Then hold the line at the top of the post (interior of the coach) and pull tight to the bottom of the post (at the same points that the glass reaches. At several midway points measure the distance from the line to the post (Figure 3).

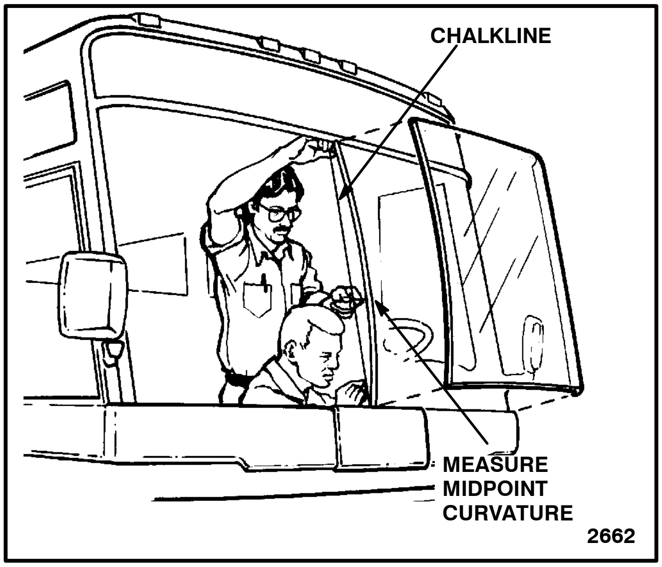


Figure 3. Checking the Bow of the Windshield Center Post

5. If the measurements are the same, replace the rubber. If the measurements are different, reshape the post to fit the glass. The post can be corrected by placing a solid wood block against the center of the post (inside or out) and using a heavy sledge hammer, strike the block to form the proper bow in the post.

NOTE: If all of the above checks and corrective actions have been taken, and it appears that the windshield(s) cannot be installed without being in a bind, then further recommendations can be obtained from the MCI Service Control Center by calling 1-800-241-2947.

DRIVER'S WINDOW

Frame

1. Remove all screws from the interior retaining frame.

2. Gently pry mounting frame out of opening with proper tools.

3. Reinstall in reverse order taking care to ensure against leakage by the proper placement of seal to outer skin panel.

NOTE: Further disassembly of the window frame may be necessary to replace slider units.

Glass Unit

1. Find the spot where the two ends of the retaining rubber meet and pry one end out.

2. Pull inner rubber retainer away from glass unit.

3. Loosen the glass unit from the outer rubber seal, and remove the glass.

4. Soak retainer rubber in warm soapy water and reinstall glass in reverse order using rubber mallet.

ENTRANCE DOOR SASH & TRANSOM

Upper Door Sash Frame

1. Remove the inner screw covering rubber.

2. Remove the screws retaining the inner frame to the outer locking frame and remove.

3. Remove the the outer locking frame with glass unit.

4. Reinstall in reverse order taking care to ensure against leakage by the proper placement of seal to outer door panel.

Lower Lucite Window

1. Remove the inner door panel to access locking strip.

2. Removing locking strip from inner rubber seal.

3. Gently push window out of rubber seal toward inside of coach.

4. Install window into seal rubber. Lubricate locking strip groove and reinstall strip. Reinstall panel in reverse order.

Transom Window

1. Insert small flat-bladed tool into outer locking seal and gently work locking seal apart all around window.

2. Unfold the locking rubber seal to remove window.

3. Install window into seal and refold.

4. Apply warm soapy water to the locking rubber and reseal using rubber mallet.

PASSENGER SIDE SASH

Mounting Frame

⚠ **WARNING** ⚠

Passenger sash frame removals and installations should be performed by more than one person.

1. Remove all screws from the interior retaining frame.

2. Gently pry mounting frame out of opening with egress frame attached.

3. Reinstall in reverse order taking care to ensure against leakage by the proper placement of seal to outer skin panel.

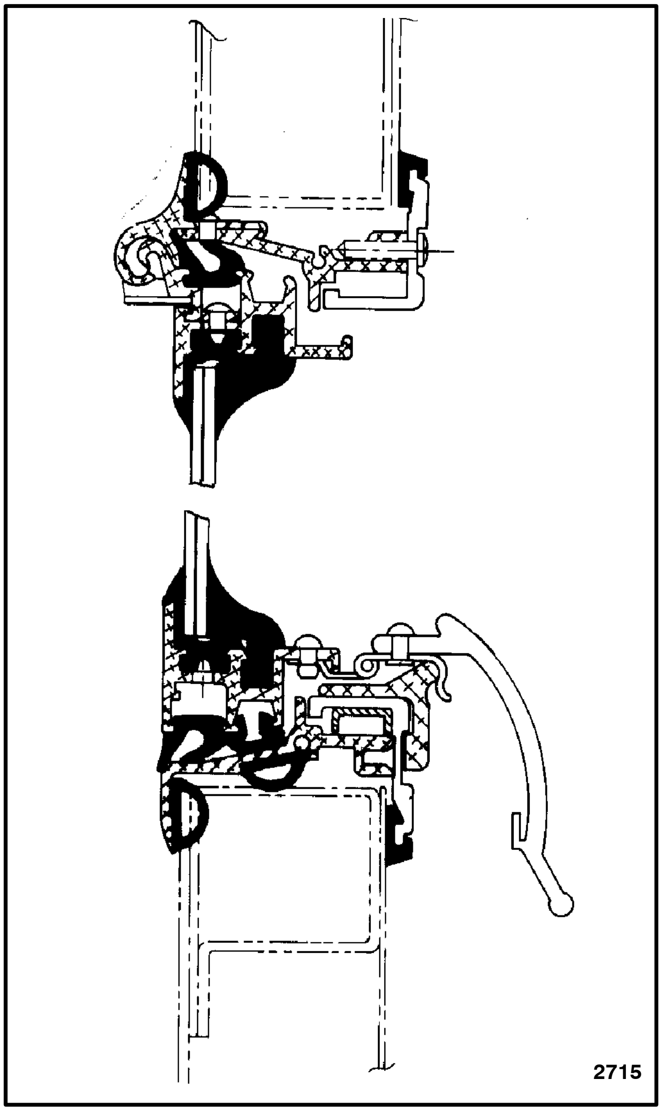


Figure 4. Side Window Cross Section

Egress Frame

1. Remove the screws and retainer clips from the hinges.

2. Swing the window out far enough to disengage the frame extrusions and remove.

3. Reinstall in reverse order.

Glass Unit

1. Find the spot where the two ends of the retaining rubber meet and pry one end out.

2. Pull inner rubber retainer away from glass unit (Figure 4)

3. Loosen the glass unit from the outer rubber seal, and remove the glass.

4. Soak retainer rubber in warm soapy water and reinstall glass in reverse order.

NOTE: All side window glass units on a given coach are interchangeable with one another. Single and double-glazed glass use different interior retaining rubber seals.

Release Bar

1. Drill out rivets attaching release bar to egress frame hinge assemblies.

2. Mount new release bar to hinge and rivet together.

SPECIFICATIONS

PASSENGER SASH ASSEMBLY

Manufacturer	Machine-Rite
Part Number (Single-Glazed LH/RH)	3L-27-133
Part Number (Double-Glazed LH/RH)	3L-27-107
Part Number (Single-Glazed LH Rear)	3L-27-134
Part Number (Double-Glazed LH Rear)	3L-27-108
Part Number (Single-Glazed RH Rear)	3L-27-135
Part Number (Double-Glazed RH Rear)	3L-27-109
Part Number (Single-Glazed RH Rear W/Lavatory 102DL3)	3L-27-144
Part Number (Single-Glazed RH Rear W/Lavatory 102D3)	3L-27-139
Part Number (Single-Glazed RH Rear W/Large Lavatory 102DL3)	3L-27-147
Part Number (Single-Glazed RH Rear W/Large Lavatory 102D3)	3L-27-142
Part Number (Double-Glazed RH Rear W/Lavatory 102DL3)	3L-27-146
Part Number (Double-Glazed RH Rear W/Lavatory 102D3)	3L-27-141
Part Number (Double-Glazed RH Rear W/Large Lavatory 102DL3)	3L-27-149
Part Number (Double-Glazed RH Rear W/Large Lavatory 102D3)	3L-27-110

DRIVER'S WINDOW ASSEMBLY

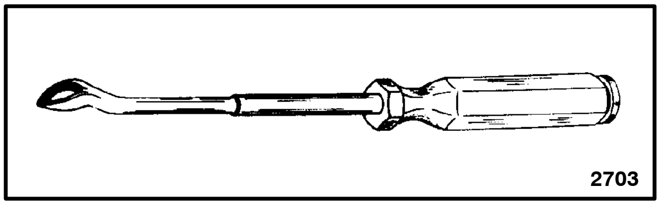
Manufacturer	Machine-Rite
Part Number (Single-Glazed Small Slider)	3L-14-59
Part Number (Double-Glazed Small Slider)	3L-14-58
Part Number (Single-Glazed Large Slider)	3L-14-88
Part Number (Double-Glazed Large Slider)	3L-14-69

WINDSHIELD & UPPER WINDSCREEN GLASS

Part Number (LH/RH)	3J-27-17
Part Number (Tinted LH)	3K-27-27
Part Number (Tinted RH)	3K-27-28
Part Number (Upper Windscreen)	3L-27-1

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES CORPORATION AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20 – NPN1703: Lacing Tool, $^{9}/_{16}$--inch Eye

SECTION 3F

LIFTING AND TOWING

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 3F-1
Service Tools 3F-4

GENERAL DESCRIPTION

If a disabled 102 D series coach should ever need to be towed or jacked, there are some basic rules, procedures and safety precautions that should be strictly followed during these operations.

When towing the coach always follow the procedures as recommended and specified in this section.

⚠ CAUTION ⚠

Coaches should only be towed by operators authorized and experienced in towing intercity coaches.

When jacking coach for tire change always use only the specified jacking locations shown in this section. Use of any other jacking location may result in damage to the coach body and/or frame.

The coach parking brakes should be applied preceding any jacking operation, or while awaiting assistance from a tow vehicle.

NON-LIFTED TOW PROCEDURE

If a disabled 102 D series coach should need to be towed without lifting the front end follow the procedure below. Read the entire procedure before starting.

1. Remove stud nuts and washers retaining axle shafts, rap axle shaft flange sharply to loosen dowels, and pull axle shaft. Plug load tubes to prevent oil loss.

⚠ CAUTION ⚠

With either automatic or manual transmission the drive axle shafts must be removed when coach is being towed to avoid possibility of damage to transmission.

2. Before attempting to tow coach, parking brakes must be released. Check the service brake air pressure on the dash mounted dual air gauge.

⚠ CAUTION ⚠

At least one service brake circuit requires full air pressure, preferably the primary (rear service brake) circuit. This will allow the park brake push-pull valve to be pushed down, allowing the locks to release and permit the park brakes to retract. A full service brake application will be required to ensure release.

Note: If both circuits are low, and the air system is intact, the entire system may be filled through the schrader valve in the RH rear service compartment. If both circuits are low and the coach won't run or generate air pressure, fill at least one using the appropriate emergency fill valve in the front LH service compartment.

3. Operate the coach engine during the tow to maintain brake system air pressure, or attach an external air pressure line, from the tow truck, to the emergency park/service brake fill valve in the front service compartment. The air pressure must be 75 psi minimum and the line should be attached via screw type or clamp-on type air connector.

⚠ CAUTION ⚠

Do not tow the coach without external air pressure applied to the emergency park /service brake air fill valves, unless engine and its air compressor are in operation. Without system air pressure, the park brakes may apply

automatically if parking air pressure falls to approximately 40 psi.

4. Position the tow truck so that the truck's tow bar contacts the front bumper of the coach.

5. Attach the tow truck chains in the coach tow eyes and take up all slack.

6. Attach safety chains as applicable.

7. Observe the normal towing precautions including, but not limited to, the ones listed below when towing the coach:

a. Make sure the park brake is released before towing by making a service brake application.

b. Do not allow passengers in the coach during towing.

c. Do not exceed a prudent, safe towing speed. Be aware of changing conditions.

d. Avoid "tight" turning. Accelerate and decelerate slowly, with caution.

e. After approximately two miles towing, check and retighten the safety and tow chains as necessary.

LIFTED TOW PROCEDURE

If a disabled 102 D series coach should need to be lifted from the ground in order to be towed follow the procedure below. Read the entire procedure before starting.

MCI has available an I-beam frame assembly which can be used for lifting and towing coaches. The lift and tow frame (part No. 20-300) is recommended whenever a coach is to be towed with the front wheels off the ground (Figure 1).

To use the frame, a hardwood plank is required for placement between the coach undercarriage and the lifting frame (Figure 2). The dimensions of the plank are minimum 4 x 8 x 60 inches.

⚠ CAUTION ⚠

Do not lift fully loaded coaches.

⚠ CAUTION ⚠

The following procedure explains the use of the lift and tow frame developed for use by authorized and experienced tow truck operators. This tool and procedure is NOT approved for any other application.

Also, this procedure explains only the recommended method to attach the tool to the coach. It does not attempt to explain or instruct personnel in all conceivable proper methods and details for safe lifting and towing of coaches. MCI recommend that this tool and procedure be used only by tow truck operators authorized and experienced in towing intercity coaches.

MCI cannot be responsible for the improper use of this equipment by inexperienced or unauthorized individuals.

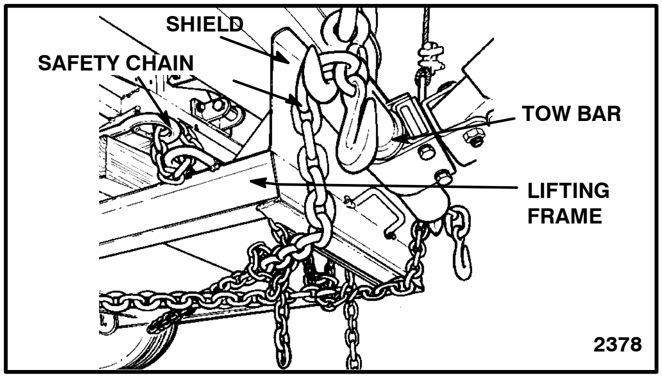


Figure 1. Lift/Tow Frame Chain Placement

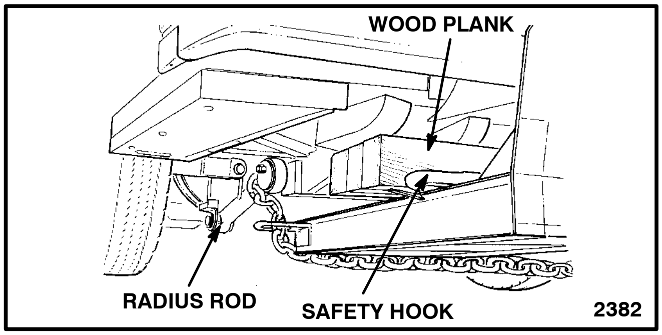


Figure 2. Lift/Tow Frame and Plank Position

1. Follow steps 1 thru 4 of the "Non-Lifted Tow" procedure.

2. Spread the tow truck lifting chains under the front area of the coach in an "X" configuration. Approximately two feet of the end of the typical tow truck chain should extend out from under the coach, past the bumper.

3. Roll the lift frame under the coach (over the chains) until the front shield is below, and slightly in front of, the coach bumper. The frame must be laterally centered under the coach center line.

4. Raise the rear of the lift frame until it contacts the coach undercarriage near the front of the radius rods. Support the rear of the frame in this position.

5. Wrap the tow chains around the radius rods in the following manner as shown in (Figures 1 & 2).

a. Bring each chain up through the "D" ring on the lift frame.

b. Wrap the chain around the radius rod from inside to outside.

c. Secure the hook onto the chain, as tight as possible, on the radius rod.

6. Place the hardwood plank on the frame so that when the frame is raised, the plank will contact the tow hooks or eye support area on the coach. If the bus has a retractable step, keep the plank approximately 4 inches away from the step.

7. Raise the front of the lift frame and locate the shield in front of, and tight against, the bumper. Support the frame in this position. Locate the plank directly under the coach tow eye support.

8. At opposite corners from each radius rod, bring the tow chains up the front of the frame shield and around the lift bar on the tow truck.

⚠ CAUTION ⚠

Take precautions to eliminate the slack from the chains under the frame before lifting the coach. This will ensure the truck tow bar does not “ride up” over the shield and against the front of the coach.

9. Check that the plank is in proper location against the coach tow eyes. Carefully raise the coach front with the tow truck winch.

10. Place two safety chains at the front of the lift frame as follows:

a. Route each chain down through the tow hook on the coach frame.

b. Bring the chain down the outside, and up through the safety hook on the lift frame.

c. Secure the hook onto the chain to provide a tight attachment.

11. Bring the free end of each safety chain across to the opposite lifting chain. Tighten by using a chain tensioner to eliminate all slack. Make sure the safety chains are tight to prevent side-slip of the lift frame under the coach.

12. Observe the normal precautions including, but not limited to, the ones listed below when towing the coach:

a. Make sure the park brake is released before towing.

b. Do not allow passengers inside the coach during towing.

c. Do not exceed a prudent, safe towing speed. Be aware of changing conditions.

d. Avoid “tight” turning. Accelerate and decelerate slowly, with caution.

e. After approximately two miles towing, check and retighten the safety chains as necessary.

JACKING POINTS

When it is necessary to raise the vehicle by using jacks, care should be taken to ensure that jacks are located only at the specified locations (Figures 3 – 5). Other locations may cause frame distortion and or body damage.

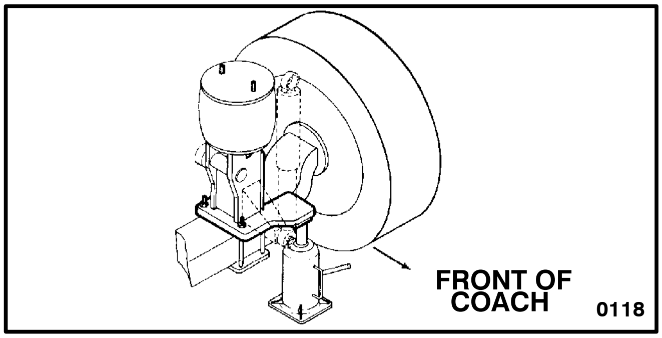


Figure 3. Front Jacking Points

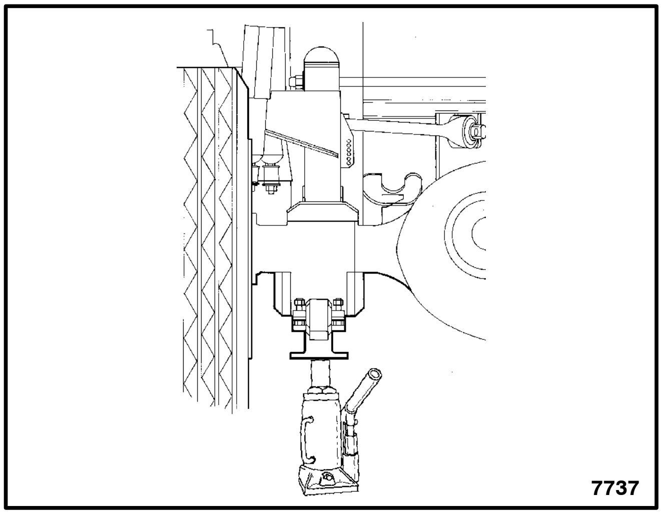


Figure 4. Drive Axle Jacking Points

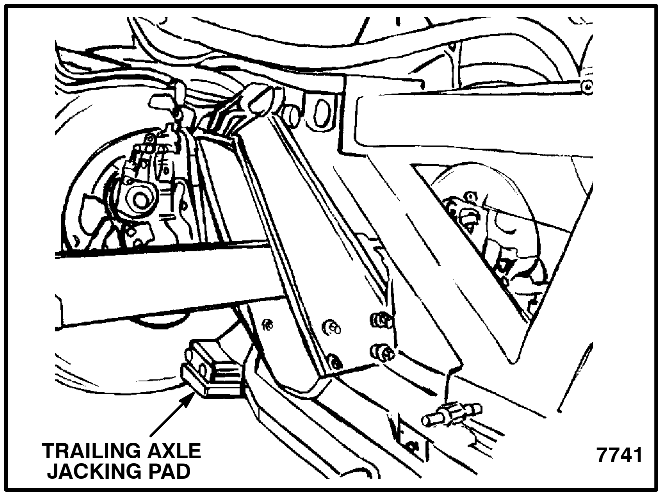
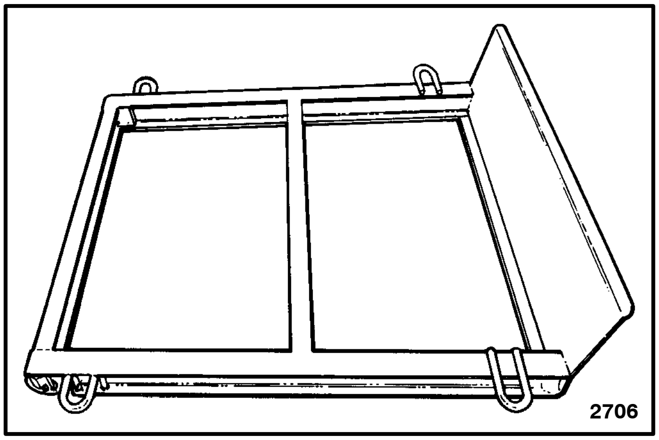


Figure 5. Trailing Axle Jacking Points

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20 - 300: Lift and Tow Dolly

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 3G

LIFTING AND TOWING

(As of Unit # 47071)

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 3G-1

Service Tools 3G-4

GENERAL DESCRIPTION

If a disabled 102 D series coach should ever need to be towed or jacked, there are some basic rules, procedures and safety precautions that should be strictly followed during these operations.

When towing the coach always follow the procedures as recommended and specified in this section.

⚠ CAUTION ⚠

Coaches should only be towed by operators authorized and experienced in towing intercity coaches.

When jacking coach for tire change always use only the specified jacking locations shown in this section. Use of any other jacking location may result in damage to the coach body and/or frame.

The coach parking brakes should be applied preceding any jacking operation, or while awaiting assistance from a tow vehicle.

NON-LIFTED TOW PROCEDURE

If a disabled 102 D series coach should need to be towed without lifting the front end follow the procedure below. Read the entire procedure before starting.

1. Remove stud nuts and washers retaining axle shafts, rap axle shaft flange sharply to loosen dowels, and pull axle shaft. Plug load tubes to prevent oil loss.

⚠ CAUTION ⚠

With either automatic or manual transmission the drive axle shafts must be removed when coach is being towed to avoid possibility of damage to transmission.

2. Before attempting to tow coach, parking brakes must be released. Check the service brake air pressure on the dash mounted dual air gauge.

⚠ CAUTION ⚠

At least one service brake circuit requires full air pressure, preferably the primary (rear service brake) circuit. This will allow the park brake push-pull valve to be pushed down, allowing the locks to release and permit the park brakes to retract. A full service brake application will be required to ensure release.

Note: If both circuits are low, and the air system is intact, the entire system may be filled through the schrader valve in the RH rear service compartment. If both circuits are low and the coach won't run or generate air pressure, fill at least one using the appropriate emergency fill valve in the front LH service compartment.

3. Operate the coach engine during the tow to maintain brake system air pressure, or attach an external air pressure line, from the tow truck, to the emergency park/service brake fill valve in the front service compartment. The air pressure must be 75 psi minimum and the line should be attached via screw type or clamp-on type air connector.

⚠ CAUTION ⚠

Do not tow the coach without external air pressure applied to the emergency park /service brake air fill valves, unless engine and its air compressor are in operation. Without system air pressure, the park brakes may apply automatically if parking air pressure falls to approximately 40 psi.

4. Position the tow truck so that the truck's tow bar contacts the front bumper of the coach.

5. Attach the tow truck chains in the coach tow eyes and take up all slack.

6. Attach safety chains as applicable.

7. Observe the normal towing precautions including, but not limited to, the ones listed below when towing the coach:

a. Make sure the park brake is released before towing by making a service brake application.

b. Do not allow passengers in the coach during towing.

c. Do not exceed a prudent, safe towing speed. Be aware of changing conditions.

d. Avoid "tight" turning. Accelerate and decelerate slowly, with caution.

e. After approximately two miles towing, check and retighten the safety and tow chains as necessary.

LIFTED TOW PROCEDURE

If a disabled 102 D series coach should need to be lifted from the ground in order to be towed follow the procedure below. Read the entire procedure before starting.

MCI has available an I-beam frame assembly which can be used for lifting and towing coaches. The lift and tow frame (part No. 20-414) is recommended whenever a coach is to be towed with the front wheels off the ground (Figure 1).

⚠ CAUTION ⚠

Do not lift fully loaded coaches.

⚠ CAUTION ⚠

The following procedure explains the use of the lift and tow frame developed for use by authorized and experienced tow truck operators. This tool and procedure is NOT approved for any other application.

Also, this procedure explains only the recommended method to attach the tool to the coach. It does not attempt to explain or instruct personnel in all conceivable proper methods and details for safe lifting and towing of coaches. MCI recommend that this tool and procedure be used only by tow truck operators authorized and experienced in towing intercity coaches.

MCI cannot be responsible for the improper use of this equipment by inexperienced or unauthorized individuals.

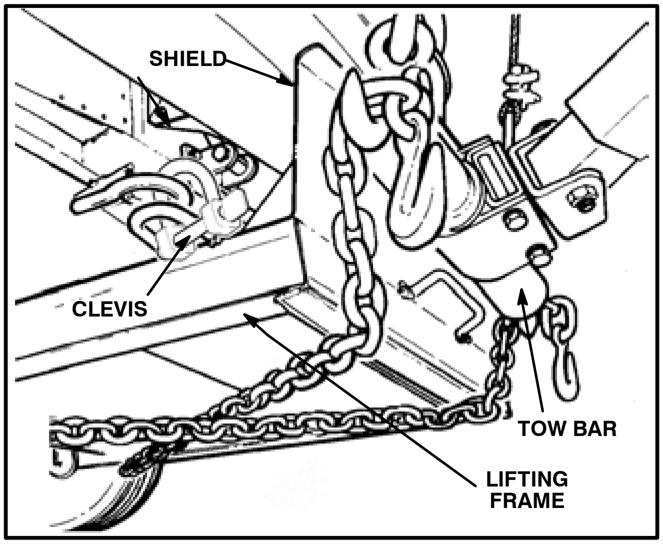


Figure 1. Lift/Tow Frame Chain Placement

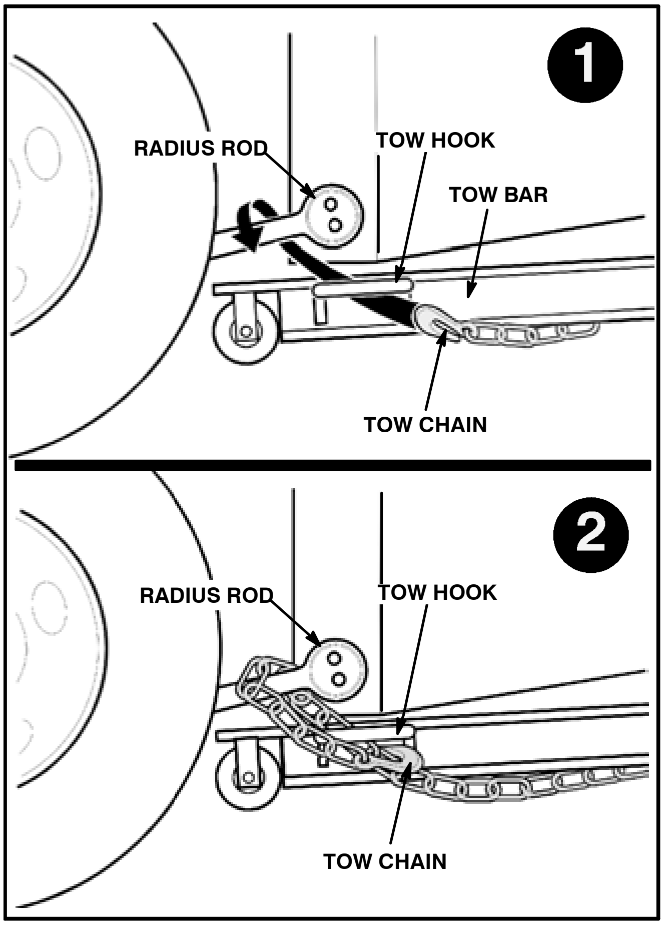


Figure 2. Lift/Tow Frame Position

1. Follow steps 1 thru 4 of the "Non-Lifted Tow" procedure.

2. Lock tag axle for 102DL3 coaches only. Tag axle override switch should be in the locked position if the coach is towed with the master switch ON.

3. Chain up front axle.

4. Spread the tow truck lifting chains under the front area of the coach in an "X" configuration. Approximately two feet of the end of the typical tow truck chain should extend out from under the coach, past the bumper.

5. Roll the lift frame under the coach (over the chains) until the front shield is below, and slightly in front of, the coach bumper. The frame must be laterally centered under the coach center line.

6. Raise the rear of the lift frame until it contacts the coach undercarriage near the front of the radius rods. Support the rear of the frame in this position.

7. Wrap the tow chains around the radius rods in the following manner as shown in (Figures 1 & 2).

a. Bring each chain up through the "D" ring on the lift frame.

b. Wrap the chain around the radius rod from inside to outside.

c. Secure the hook onto the chain, under the "D" ring as tight as possible, on the radius rod.

8. Raise the front of the lift frame and locate the lift frame onto the skid plates. The skid plates should sit inside the lift frame channels. The stops on the lift frame should be immediately in front of the skid plates. Support the frame in this position..

9. At opposite corners from each radius rod, bring the tow chains up the front of the frame shield and around the lift bar on the tow truck.

⚠ CAUTION ⚠

Take precautions to eliminate the slack from the chains under the frame before lifting the coach. This will ensure the truck tow bar does not "ride up" over the shield and against the front of the coach.

10. Place two clevises at the front of the lift frame through the "D" rings on the lift frame and the tow eyes on the coach frame.:

a. Place a protective carpet or similar material between the lift frame shield and the bumper to minimize scuffing of the bumper.

11. Observe the normal precautions including, but not limited to, the ones listed below when towing the coach:

a. Make sure the park brake is released before towing.

b. Do not allow passengers inside the coach during towing.

c. Do not exceed a prudent, safe towing speed. Be aware of changing conditions.

d. Avoid "tight" turning. Accelerate and decelerate slowly, with caution.

e. After approximately two miles towing, check and retighten the safety chains as necessary.

JACKING POINTS

When it is necessary to raise the vehicle by using jacks, care should be taken to ensure that jacks are located only at the specified locations (Figures 3, 4 & 5). Other locations may cause frame distortion and or body damage.

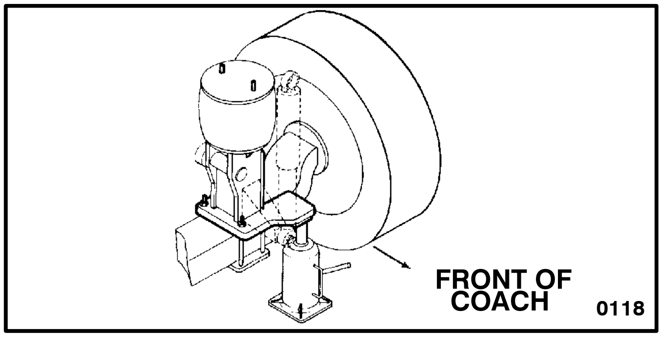


Figure 3. Front Jacking Points

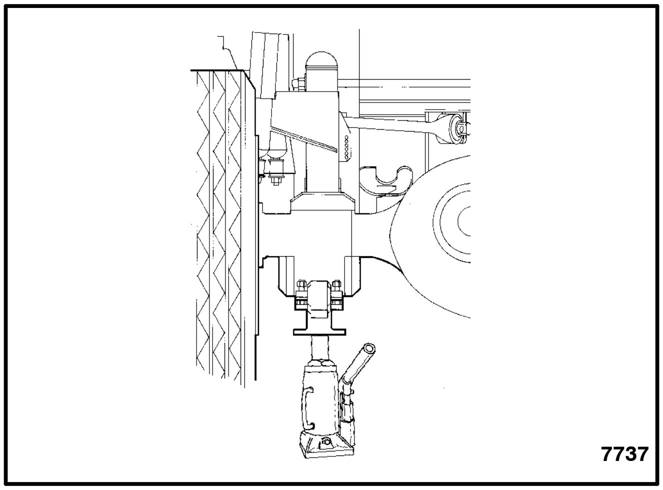


Figure 4. Drive Axle Jacking Points

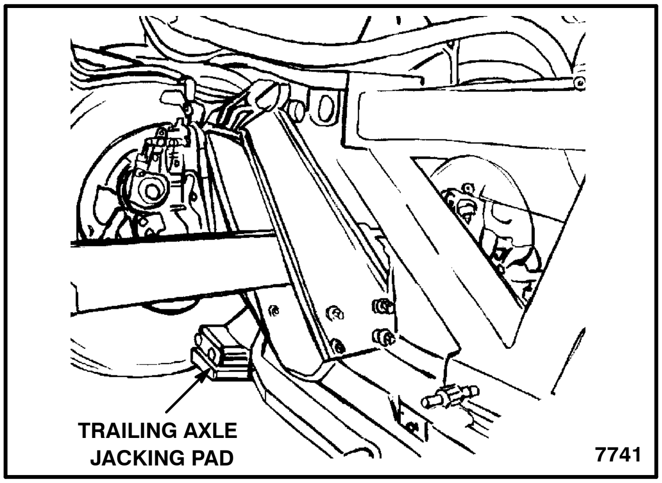
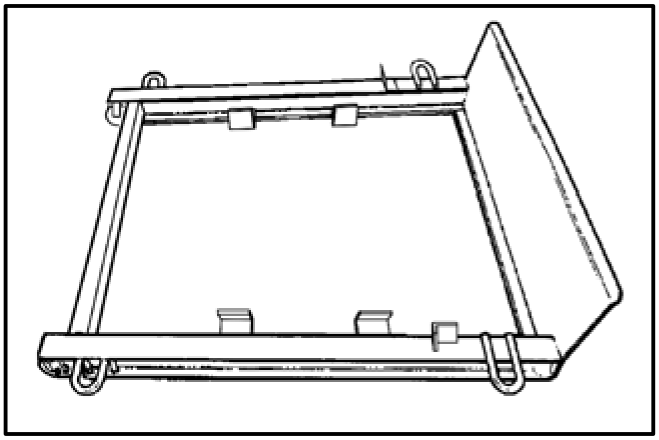


Figure 5. Trailing Axle Jacking Points

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20 - 414: Lift and Tow Dolly

SECTION 4

AIR SYSTEM & BRAKES

This section consists of six primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The six primary subsections are:

A - Air Systems (Introduction)
B - AD-9 Air Dryer
C1 - Drum Brakes
C2 - Disc Brakes
D - Air Control Components
E - Air Compressor and Governor

SECTION 4A

AIR SYSTEMS

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 4A-1
Components 4A-2
Operation 4A-4
Maintenance 4A-8
Troubleshooting Air System 4A-9
Schematics 4A-11

GENERAL DESCRIPTION

The D series combined pressurized air system is responsible for performing and/or maintaining several different and vital coach functions. Functions such as service brakes, suspension capabilities, belt tensioning and even compartment door locking are pneumatically actuated, and are provided for as part of the overall air system. In order to better explain, describe or further clarify all air system functions and their related components, several system flow diagrams accompany this section.

This maintenance manual section will focus on providing a working knowledge of air systems as they relate to other sections of this manual. However, all of the information concerning specific operation and/or components of the air system may not be contained herein. To help familiarize and better understand the air system components, we have divided them into specific categories or groups for detailed review. Four (4) separate and distinct systems have been identified and titled as follows: “Air Production”, “Air Brakes”, “Air Suspension” and “Accessory Air Systems”.

AIR PRODUCTION SYSTEM

The first of these groups deals primarily with the production, regulating, conditioning and storage of the compressed air used throughout all of the other systems. This system is interconnected to all other systems via the reservoirs. Some of this group’s components will be discussed in detail within their own separate maintenance manual sections.

AIR BRAKE SYSTEM

The second of these groups describes both the service and park brake air system circuits. This segment will address the operation and control of each circuit. The service brake portion utilizes a dual air circuit consisting of separate primary and secondary service air reservoirs. The park/emergency brake air circuit also features a separate air reservoir isolated from the service brakes. The components in this group will be discussed in detail herein and in other sub-sections of the maintenance manual.

This system is interconnected to the air production system via the primary and secondary service reservoirs and the park/emergency reservoir. The components of this group will be discussed in detail herein. Other components interconnected and/or related to this system are also discussed here and in later sections of this maintenance manual.

AIR SUSPENSION SYSTEM

The suspension system includes all components related to maintaining proper axle-to-road contact and coach ride height (i.e., air springs, leveling valves, actuator springs and trailing axle castering mechanism) This system is interconnected to all other systems via the air production and accessory air systems. Some of the components in this group will be discussed in detail herein and others in later sections of this maintenance manual.

ACCESSORY AIR SYSTEM

The accessory air system is comprised of all other pneumatic components (i.e., air operated wipers, entrance door, radiator shutters, retractable step, air cylinders and other air-actuated devices, etc.) These and other devices would be connected to and supplied by the accessory and suspension air systems. Some of the components in this group will be discussed in detail here and in other sections of this maintenance manual.

COMPONENTS

AIR PRODUCTION SYSTEM

Compressor

The engine driven Bendix TU-FLO 750 air compressor produces all of the compressed air required for use in the various systems. The air compressor is mounted to the right side of the engine assembly. A complete breakdown of maintenance information on the compressor can be found in Section 4E.

Air Dryer

The D series coaches are equipped with the Bendix AD-9 air dryer. The air dryer removes all latent condensation or moisture from the air received from the compressor discharge line. The filter/dryer assembly is located across from the secondary reservoir, and mounted on the front bogie crossmember panel. A complete breakdown of maintenance information on the air dryer can be found in Section 4B.

Governor

The Bendix D-2 air compressor governor is used on all coaches. The governor regulates the compressor discharge to the dryer through a dryer control air line. The governor is mounted to the air compressor assembly. Further information on the governor can also be found in Section 4E.

Reservoirs

The pressurized air for each of the air systems' four sub-groups is held in one or more of the five (5) reservoirs mounted at various locations along the coach. The air brake system has a "stand alone" isolated supply with its own separate air reservoirs. The wet and accessory reservoirs are interconnected to all of the systems either directly or indirectly. For example, an accessory system device might receive its supply air through an air suspension system line.

The wet tank receives and holds all of the filter/dryers output air. The wet tank, in conjunction with the other reservoirs, catches condensate and allows the pressure to equalize. The wet tank does not provide any pressurized air directly to any other system components. It, in turn, feeds all other reservoirs as required. The wet tank is located adjacent to the secondary service brake circuit reservoir, and mounted on the bulkhead to the rear of the front axle.

The rear service or primary reservoir receives and stores supply air for normal rear and trailing axle service brake applications. This reservoir is isolated from the park/emergency reservoir. The primary service tank is located adjacent to the park/emergency reservoir at the front of the rear wheelhouse, and mounts to the rear baggage bay bulkhead.

The front service or secondary reservoir receives and stores supply air for normal front axle service brake applications. This reservoir is also isolated from the park/emergency reservoir. The secondary service tank is located adjacent to the wet tank, and mounted on the bulkhead to the rear of the front axle

The park/emergency reservoir holds supply air for normal and emergency actuation of the park brake circuit. This tank is filled through the wet tank distribution via the pressure protection valve. This reservoir is isolated by check valve from other brake circuits or air systems. The park/emergency reservoir is located adjacent to the primary reservoir at the front of the rear wheelhouse, and mounts to the rear baggage bay bulkhead.

NOTE: All three of the air brake circuits can be emergency filled through the schrader valves located in the front LH service compartment.

The accessory air reservoir stores supply air for various air operated devices and components of the coach. This tank is filled through the wet tanks normal distribution. The accessory air reservoir is located in the front LH service compartment area.

AIR BRAKE SYSTEM

Service Brake Valve

The Bendix E-10 brake valve is a remote mounted, treadle-actuated, dual circuit type valve. This valve features two separate supply and delivery circuits for application of primary and secondary service brakes, and emergency modulated braking. The primary air circuit is controlled by the upper portion of the valve, while the lower portion controls the secondary circuit.

The valve provides the driver with graduated control for applying and releasing vehicle brakes. The valve is located inside the tire compartment mounted to the front bogie crossmember. The valve is actuated by the brake pedal which is mounted adjacent to the accelerator pedal assembly, and operates the valve via the pedal-to valve linkage rod.

NOTE: The brake valve installation incorporates a preliminary and secondary stoplight switch arrangement.

Park Brake Valve

The Bendix PP-2 push-pull park brake control valve is a manually-operated on-off park brake control valve. This valve is pressure actuated to allow for automatic movement from an exhaust position to an applied position under certain low pressure conditions. Air supply for park brake function is provided through the park/emergency reservoirs isolated circuit. The park brake valve is mounted to the drivers right hand floor console.

Quick Release Valve

The Bendix QR-1 quick release valve speeds the exhaust of the front brake chamber air pressure. The valve is located on the front bogie panel.

Double Check Valves

The Bendix DC-4 double check valves control the distribution of air between components and/or circuits. The higher pressure air at one of two supply ports moves the blocking disc valve from its seat and allows flow out the third port. The check valve is responsible for the emergency application of parking brakes and mounted on the inversion valve delivery port.

NOTE: The operation of front and rear suspension leveling features also utilizes this type check valve.

Relay Valve

The Bendix R-14 relay valve is normally used in rear brake operational control functions. The R-14 valve operates as a remote controlled brake valve that delivers or releases air to the service portion of the drive and trailing axle brake chambers, and it additionally incorporates anti-compounding features for service and parking brake functions. The relay valve is mounted to the channel assembly between the drive and tag axles.

NOTE: R-12 relay valves are also used in the operation of the front and rear suspension systems.

Inversion Valve

The Bendix TR-2 inversion valve is a pilot-operated, inverting, on-off, two-way valve. The valve has three common control ports, a supply port and a delivery port. The valve is used in conjunction with the DD3 chamber and park brake circuit to control the emergency application of air, and also to keep locks released during normal service applications. The inversion valve is mounted on the rear drive axle.

Emergency Standby Valve

The Bendix TR-2 inversion valve is also used in the control circuit for emergency park brake applications, and modulated braking of the secondary circuit. This valve is used in conjunction with the emergency brake application double check valve. The valve is located inside the tire compartment.

Brake Chambers

Diaphragm type brake chambers convert the energy of compressed air into a mechanical force. Two basic types of brake chambers are used in the air brake system installations. Single diaphragmed brake chambers are used on front and trailing axle brakes, while double diaphragmed brake chambers are used exclusively on the drive axle brake assemblies. Brake chambers are located at each wheel end brake assembly, and have different design and exterior appearances.

Anti-lock Valve

The Bendix M-21 anti-lock modulator valve is a high capacity, solenoid operated, on/off air valve that controls the flow of air to the brake chamber on all anti-lock brake installations. This valve is mounted to the channel assembly on rear axle installations, and to the front bogie panel on front installations.

AIR SUSPENSION SYSTEM

Air Spring Assembly

The air spring bellows are made from a special rubber compound, and molded to specific pressure retaining contours and/or dimensions. All suspension air springs are rolling lobe type design. The air springs are bolted to all axle and chassis supports, and are inflated throughout the leveling valve control of each axle. The front and trailing axles require two air spring assemblies, while the rear axles have four air springs.

NOTE: Liftable tag axle installations are equipped with double convoluted air spring actuators in addition to the normal air spring assemblies.

Suspension Filter

A Bendix type E suspension filter is installed into the suspension, accessory and emergency/park reservoir air circuit as a final filter before entering components of these systems. The grey filter is mounted adjacent to the secondary air reservoir behind the front axle.

NOTE: Effective with 48249 this filter was replaced with an inline type filter mounted on the wet tank supply.

Pressure Protection Valve

A pressure protection valve is incorporated into the suspension, accessory and emergency/park reservoir air systems and circuits to prevent over-pressurizing of the air spring bellows and other components. The valve is mounted adjacent to the main water valve inside the evaporator/blower compartment.

NOTE: Effective with unit 48314, the main pressure protection valve was changed. The old valve was set to close at 65 psi and re-open at 75-80 psi The new valve is set to close at 80 psi and re-open at 95 psi.

Leveling Valves

The Delco height/level control valves maintain a constant pressure in and uniform loading of the air springs regardless of the load. The suspension height control system is entirely automatic in operation and designed to maintain a constant vehicle height. This air circuit is interconnected with the trailing axle suspension unloading circuit.

Trailing Axle Unloading Valves

The Watts tag unloading valves are full-port, manually-operated trailing axle air dump/fill valves. The valves provide for the exhausting and filling of the trailing axle air springs as conditions require. The dual valve installations are mounted to the upper front of the RH rear side service door frame.

NOTE: Coaches may be optionally equipped with the electrically controlled trailing axle unloading system, featuring dual solenoid operated "Skinner" control valves. Unloading/Retracting feature has dual solenoid operated "Norgren" control valves.

Trailing Axle Caster Control Valve

The Norgren self-steering trailing axle solenoid control valve automatically operates the latching and locking mechanisms air cylinders of the castering system, in conjunction with the speed switch. The trailing axle caster control valve is mounted inside the rear junction box.

ACCESSORY AIR SYSTEM

Hot Water Valve

Electrically-actuated, air-operated, on-off type hot water valves are used on this coach. The main valve is mounted adjacent to the pressure protection valve inside the evaporator/blower compartment. The by-pass valve for the auxiliary heater is mounted to the upper LH area of the rear bulkhead inside the engine compartment.

Wiper Motors

Two heavy-duty variable-speed, air-operated wiper motors are installed below the windshields and behind the front exterior cap. The wiper motor control valves have built-in pressure regulators.

Air Cylinders

Various single and double-acting air cylinder actuators are fitted throughout the coach. The control mechanisms for these cylinders may be located adjacent to the actuator, or they may be remote mounted.

NOTE: The above items can be located on the "Systems and Components Diagram" found at the rear of this section.

OPERATION

AIR PRODUCTION SYSTEM

The compressor is driven by the coach engine and operates continuously while the engine is running. However, the compressor unloading mechanism, in conjunction with the governor and air dryer pilot line, controls the actual volume and amount of air that is compressed. The governor maintains the air system pressure to preset maximum and minimum pressure levels (loads-up at 90 psi unload at 120 psi ± 5 psi).

As discharge air from the compressor moves through the line to the air dryer, it passes through the condensate sump (ping tank) where water collects. Water collected in the sump must be drained periodically through the sump drain valve. The compressed air enters the air dryer reservoir where it is filtered and heated to remove the remaining condensate. As the dryer fills, pressure builds in the dryer and in the pilot line going back to the governor. When the pressure reaches the unloader set point the compressor valves unload, and the compressor remains turning.

The filtered and dried air flows out of the air dryer and through a check valve into the wet tank. Inside this tank the pressure equalizes and any remaining condensate settles to the tank bottom. The pressurized air from the wet tank is then distributed to the other reservoirs of the air system and/or routed directly to components via the suspension filter and pressure protection devices.

NOTE: A flow diagram representative of the above operational description can be located in the "Compressor, Reservoirs & Suspension" air flow diagram found at the rear of this section.

AIR BRAKE SYSTEM

Service Brake (Normal Application)

The primary (rear) and secondary (front) service brake air circuits are energized when a normal service brake application is made via the E-10 or E-15 brake valve. As the valve is depressed, supply air flows through the primary (upper) portion of the valve to the delivery port. The primary delivery port routes air to the R-14 relay valve control port.

The R-14 relay valve is actuated by the pressurized control port, which allows supply port air from the primary air reservoir to flow through to the delivery ports. Delivery ports are plumbed to the trailing axle brake chambers and also to the service portion of the rear brake chambers.

Supply air flows through the secondary portion of the valve to the delivery port as the valve is further depressed. The secondary delivery port routes air to the quick release valve supply port. As air enters the supply port of the quick release valve the internal diaphragm closes the exhaust port and flows through the delivery ports to the front brake chambers.

Both the primary and secondary delivery ports route air to the preliminary and secondary stoplight switches, and on to the exterior brake lights. Primary and secondary supply air lines are routed from the brake valve to a dual air gauge for display. A primary delivery port line routes air to the exhaust port of the park brake valve for anti-compound operation. A secondary delivery line routes air to the supply port of the emergency standby valve, and a primary supply line routes air to the control port for emergency modulated brake applications.

NOTE: During normal service brake applications the park brake valve is in the released (down) position.

With park brake released, pressurized air from the park/emergency reservoir flows through the park valve supply port and out the delivery to the supply port of the SV-1 synchro valve of the interlock assembly. Because the synchro valve has sufficient pressure at the control port, supply is opened to the delivery port and flows out to one of the control ports of the inversion valve. The control air is routed to each of the lock ports of the rear brake chambers thereby keeping them released for normal service brake applications. The control air also closes the internal piston of the inversion valve, and blocks park/emergency supply air from delivery to the park portion of the brake chambers.

Service Brake (Modulated Application)

If a low air condition occurs in the E-10 or E-15 brake valve's primary service brake supply circuit, the secondary service brake air delivery circuit should compensate by making modulated brake applications. When the service brakes are energized during a primary (rear) circuit low air condition, air from the secondary delivery is routed to the emergency standby valve supply port.

NOTE: The emergency standby valve requires control air to keep supply to delivery closed.

On descending control port pressure, the piston return spring overcomes the control pressure and opens supply to delivery ports. The secondary (front) circuit air flows through the emergency standby valve to the rear emergency double check valve. The higher pressure moves the check and routes air to the emergency portion of the DD3 brake chambers. After making a modulated brake application the delivery line is exhausted through the exhaust port of the emergency standby valve.

NOTE: No provision for modulated application is made when a low secondary supply circuit condition exists, because the primary service braking at rear and trailing axles should be sufficient to stop the coach.

Service Brake (Released)

When the normal service brake application is released, the primary and secondary supply ports are closed and the delivery ports are opened to exhaust. The primary circuit control air from the R-14 relay valve, and secondary circuit supply air from the QR-1 quick release valve are exhausted through the brake valve. The secondary (front) circuit brake chambers are exhausted through the QR-1 quick release valve, while the primary (rear) circuit brake chambers are exhausted through the R-14 relay valve exhaust.

Parking Brake (Normal Application)

A normal parking brake application would occur after the coach has come to a complete stop and the service brake application is released. The park brake valve would be pulled up to set the brake. When the valve is placed in this position, supply air from the park/emergency reservoir is blocked and the delivery is opened to the exhaust port.

Without the park valve delivery line pressure at the synchro valve control port, the synchro valve spring tension closes the valve and exhausts the control line of the inversion valve. Without the inversion valve control pressures the DD3 brake chamber lock mechanisms engage. As air flows out of the control port, the inversion valve spring tension closes the internal piston and opens the delivery port to park/emergency reservoir supply. The delivery routes air to the park/emergency portion of the DD3 brake chamber and applies the parking brake.

NOTE: Locks prevent push rod movement only in the retracting (release) direction, not during extension (brake application).

Parking Brake (Emergency Application)

An emergency park brake application should occur whenever the park/emergency reservoir pressure drops below the minimum set point pressure (approximately 45 psi). As the pressure drops in this circuit, the park valve spring tension moves the valve to the applied (up) position. This will cause the locks to engage during the next rear service brake application.

NOTE: Always fill the park/emergency brake circuit first after a loss of air pressure in the park/emergency reservoir circuit. The park brake valve must be in the "Up" position to fill properly.

AIR SUSPENSION SYSTEM

Leveling

The coach suspension system automatically maintains proper ride height at front and rear axle locations through suspension air spring inflation and exhausting controlled by the leveling valves. Pressurized air from the suspension/accessory circuits is used for leveling operations.

The wet tank via the suspension air filter and pressure protection valve and accessory air reservoirs feed the circuits that provide pressurized air to all of the suspension air system components. The front and rear suspensions are supplied by a common air circuit joining front and rear junction blocks, however, the front and rear suspensions may be filled independently of each other.

Air flows through the front (single) or rear (dual) leveling valve circuits to the air springs. The leveling valves are mounted to the chassis, and connected to the axles by an arm and fixed length link arrangement. When air springs are deflated, the leveling valve arm would be in an upward position. The fixed link from the control valve to the coach frame is moved and opens the valve supply to delivery with coach loading. Flow through the control valve is routed through the trailing axle unloading control valves for unloading operations. As the air spring bellows fill and the coach rises, the stationary valve arm is pulled down by the attached axle link. This closes the valve and shuts off air flow to the air spring.

Conversely, if the leveling valve has applied more air than is needed to the air springs, i.e., loading and unloading operations, the added lift from unloaded air springs should pull the arm down and exhaust the excess air. Leveling valve operations are purposely delayed through sizing of supply and exhaust ports and/or air lines.

⚠ **WARNING** ⚠

Avoid accessing the suspension components from outside coach wheel well areas. Unintentional actuation of the height control valves with fully inflated air springs could result in serious injury. Always block the coach body adequately during any inspections and/or repairs in these areas.

Because of the delay mechanism in each height control valve, the valves respond only to sustained variations in the height of the axles in relationship to the coach body. Thus no change in air pressure takes place during normal driving.

However, the valves automatically regulate air pressure to compensate for changes in the load carried by the coach, or due to changes in the location of the coach load. For more information on the leveling control system see Section 12E.

Unloading Or Lifting

The suspension system also features manually operated trailing axle fill and exhaust control valves as basic equipment. This feature enables more weight to be transferred to the drive axle during slick or slippery road conditions.

To manually exhaust the tag axle air springs, turn the valves to the exhaust position, and fill by turning to the fill position. For more information on the tag axle unloading control system see section 12E.

Some coaches may have the electrically operated trailing axle unloading option. Each of the trailing axle suspension air springs is filled and unloaded via a dual (15 and 35 psi) regulator plumbing arrangement, in combination with a solenoid operated valve and manual tag axle control valve. Additionally, the trailing axle air suspension system is fitted with dual safety relief valves for over-pressure protection.

The manual control valves are a three-port, two-position type valve that will allow for both manual and remote filling and exhausting of the tag axle suspension. Both of the control valves receive air from a common 35 psi regulated, normally-open, solenoid valve controlled supply circuit for filling. With control valves positioned to "ON", air flows through them to the tag bellows. However, when the control valves are positioned to "OFF", the air supplied by this circuit is closed and the 35 psi bellow air is exhausted to atmosphere.

The normally-open, electrically-operated, three-port, two-position, solenoid valve also controls the remote unloading or exhausting of the tag axle air springs through the 15 psi regulator. When the trailing axle unloading switch is positioned "UP", the supply port from the 35 psi regulator is closed. The solenoid valves exhaust port, piped to the delivery side of 15 psi regulator, is now opened to the delivery (air spring) side of valve. As the air inside the bellows is 35 psi and above the 15 psig regulators set point, it should be exhausted.

NOTE: Any pressurized air in front (delivery side) of the regulator valve and above that valve's regulated pressure would normally be exhausted through the regulator body bleed hole.

Coaches equipped with the option electrically operated fully retracting trailing axle feature are able to completely lift both trailing axles up and off the ground through a dash mounted switch. The system utilizes air pressure to lift and hold the axles up during service or emergency conditions.

NOTE: Only the 102D3 model coaches have the liftable trailing axle feature.

To engage the trailing axle lift/retract function move the “Trailing Axle” positive action switch to the “On” or “Up” position. The suspension air springs should begin to exhaust and the lift actuator air springs will begin to inflate, rotating the axles up and off the pavement. When the switch is repositioned to the “Off” or “Middle” setting the lift actuator springs will deflate, and axles will return to the pavement. The suspension air springs will return the tag axles to the correct ride height and properly load them for normal travel via the rear axle suspension leveling valves.

NOTE: Filling of the trailing axle’s suspension air springs after completion of the lift function is accomplished, via common solenoid valve ports, through the rear axle suspension’s normal height control air circuits.

This feature is in addition to and works in combination with either the optional electrically controlled or the manually operated tag axle unloading systems. If specified, both of these features can be actuated (by separate switches) from the driver’s dash. The lift system is protected by a low air switch and alarm circuit. For more information on the unloading and lifting axle control see Sections 12D and 12E.

NOTE: The basic retractable trailing axle feature will utilize the optional electrically operated trailing axle unloading switch “Trail Axle”, mounted in the option location. Other combinations of this feature will mount an additional “Tag Axle Up” switch in the alternate rear box location.

⚠ CAUTION ⚠

The manually operated valves must be properly positioned to allow air back through to the bellows after lifting axles.

If operation of the coach with the trailing axles in the fully retracted position is required, the operator should refer to the specific federal, state, local and/or provincial laws governing operation in this manner.

Trailing Axle Caster Control

The 102DL3 models equipped with the self-steering trailing axle system feature several automatic functions. All of the automatically controlled functions are performed electro-mechanically by actuation of a solenoid control valve. The trailing axle caster control valve in conjunction with the speed switch, automatically control the functions of latching and locking mechanisms. Air operated cylinders actuate the latching and locking mechanisms of the steerable trailing axle.

The control valve operation is sequential. First, auto locking and unlocking is controlled by the coach speed sensor switch. Secondly, actuation of the castering mechanism is controlled via transmision gear selection (i.e., back-up light circuits) for reverse travel.

When coach is in forward travel, the latch mechanism’s double-acting air cylinder has air applied to the front side for retracted position. When in reverse travel, the latching mechanism’s air cylinder has air applied to the rear side for extending position.

At speeds less than 15 mph the locking cylinder on the tie rod unlocks, freeing the axle to track in the direction of coach travel. The locking mechanism’s double-acting air cylinder has air applied to the front side for retracted position. At speeds above 20 mph the locking cylinder locks, and allows the axle to perform as a typical trailing axle. The locking mechanism’s air cylinder has air applied to the rear side for extending position. For more information on the steerable tag axle control see Sections 12D and 12E.

ACCESSORY AIR SYSTEM

The accessory air system consists of several different type actuators. Some are simple single or double-acting air cylinders, while others may have more complex controlling, regulating, or filtering circuits. Generally, these systems are actuated by switch in conjunction with various relays and/or solenoid valves. Other systems, such as the windshield wipers and washers, are completely air operated, including variable speed controls and actuator motors.

Some of the coach accessory air operated systems are activated by taking away the pressurized air source instead of having one applied. For instance, the radiator shutters do not require air for opening. When the engine reaches operating temperature, the solenoid valve closes and spring tension opens the shutters. However, the air operated baggage door assemblies, and the air operated fan clutch mechanism require air to be locked or engaged.

Several safeguard devices are installed within the accessory air system to prevent engagement of some air operated components without sufficient air pressure. For example, the coach air conditioning compressor drive normally requires 95 psi regulated air pressure to operate properly. A low air warning and A/C system cutout switch is installed in the rear junction box to signal a low air condition and prevent A/C compressor operation.

NOTE: For more information on specific components or systems mentioned in the accessory air portion, refer to the applicable sections of the maintenance manual for those components and/or systems.

MAINTENANCE

Maintenance procedures for specific components can be found in Section 4D and 12E of this maintenance manual. Follow the maintenance intervals specified in these sections or those given in Section 10 for the air system and other related components to this system.

⚠ WARNING ⚠

To avoid personal injury when working on or around air system and components, the following precautions should be observed:

Always block vehicle wheels. Stop engine when working under a vehicle. Venting vehicle air system pressure may cause vehicle to roll. Keep hands away from chamber push rods and slack adjusters; they may apply as system pressure drops.

Vent all air pressure from system before disconnecting component hoses. Never connect or disconnect hoses or lines containing air pressure as they may tend to whip while air escapes. Never remove a component or pipe plug unless you are certain all system pressure has been vented.

Never exceed recommended air pressure and always wear safety glasses when working with air pressure. Never look into air jets or direct them toward anyone.

Never attempt to disassemble a component until you have read and understand recommended procedures. Some components contain powerful springs and injury can result if not properly disassembled. Use only proper tools and observe all precautions pertaining to use of those tools.

TROUBLESHOOTING AIR SYSTEM

1. Air Pressure Drops Quickly With Engine Stopped and Brakes Released

Leaking brake valve tubing or hose line
Compressor discharge valves leaking
Compressor governor leaking
Leaking elsewhere in the air brake system

2. Air Pressure Will Not Rise to Normal

Defective air gauge (registering incorrectly)
Excessive leakage
Reservoir drain cock open
Governor out of adjustment
No clearance at compressor unloading valves
Defective compressor

3. Air Pressure Rises to Normal Too Slowly

Excessive leakage
Clogged air cleaner
No clearance at compressor unloading valves
Engine speed too low
Compressor discharge valve leakage
Worn compressor
Excessive carbon in compressor cylinder head or discharge line

4. Air Pressure Rises Above Normal

Defective air gauge (registering incorrectly)
Compressor governor out of adjustment
Defective compressor governor
Restriction in line between governor and compressor unloading mechanism
Too much clearance at compressor unloader valves
Unloading valve cavities or unloading passage in compressor cylinder head blocked with carbon
Compressor unloading valves stuck closed

5. Compressor Fails to Maintain Sufficient Pressure in Air System

Dirty intake strainer
Restriction in compressor inlet or discharge lines or cavities
Leaking or broken discharge valves
Drive coupling slipping
Inlet valves worn excessively or stuck open
Excessive air system leakage
Excessive wear on piston rings and/or cylinders

6. Noisy Compressor Operation

Loose drive gear
Excessively worn drive coupling
Worn or burned out bearings
Excessive wear
Improper lubrication to the compressor
Restrictions in the cylinder head or discharge line

7. Compressor Passes Excessive Oil

Dirty air strainer
Oil supply lines to compressor or return lines flooded
Back pressure from engine crankcase
High inlet vacuum at the compressor
Excessive engine oil pressure
Defective oil seal or oil seal ring in end cover
Piston rings improperly installed
Excessive ring or cylinder wear

8. Compressor Knocks Continuously or Intermittently

Loose drive gear
Worn or burned out bearings
Excessive carbon deposits in compressor cylinder head

9. Compressor Fails to Unload

Defective or worn unloader pistons or bores
Inlet cavity restrictions
Defective governor
Unloader line from governor pistons kinked or the cavity beneath the unloader pistons restricted
Unloader mechanism binding or kinked

10. Dryer is Constantly “Cycling” or Purging

Excessive system leakage
Defective check valve between air dryer and wet reservoir or at air dryer outlet
Defective governor
Leakage purge valve in air dryer end cover (control side)
Compressor unloader mechanism leaking excessively

11. Water in Air System Reservoirs

Desiccant requires replacement
Air system charged from outside air source (outside air not passing through air dryer)
Air dryer not purging (see Symptom #15)
Purge (air exhaust) time insufficient due to excessive system leakage (see causes for Symptom #10)

TROUBLESHOOTING AIR SYSTEM (Contd.)

12. Safety Valve on Air Dryer "Popping Off" or Exhausting Air

Desiccant cartridge plugged or saturated
Defective check valve between air dryer outlet port and wet reservoir
Defective fittings, hose or tubing between air dryer and wet reservoir
Safety valve out of adjustment
Air pressure in the air brake system above normal
Frozen or blocked air line.

13. Constant Exhaust of Air at Air Dryer Purge Valve Exhaust or Unable to Build System Pressure

Air dryer purge valve leaking excessively
Defective governor
Purge control line connected to reservoir or exhaust port of governor
Purge valve frozen open, faulty heater or thermostat, faulty wiring, blown fuse
Inlet and outlet air connections reversed
Defective check valve between air dryer and wet reservoir
Kinked or blocked (plugged) discharge line
Excessive bends in discharge line (water collects and freezes)
Excessive system leakage

14. Air Dryer Does Not Purge or Exhaust Air

Broken, kinked, frozen, plugged or disconnected purge control line
Faulty air dryer purge valve
See causes for Symptom #14

15. Desiccant Material Being Expelled from Air Dryer Purge Valve Exhaust (may look like whitish liquid or paste or small beads)

This symptom is almost always accompanied by one or more of 11 to 15; see related causes for these symptoms above
Air dryer not securely mounted (excessive vibration)

Or Unsatisfactory Desiccant Life

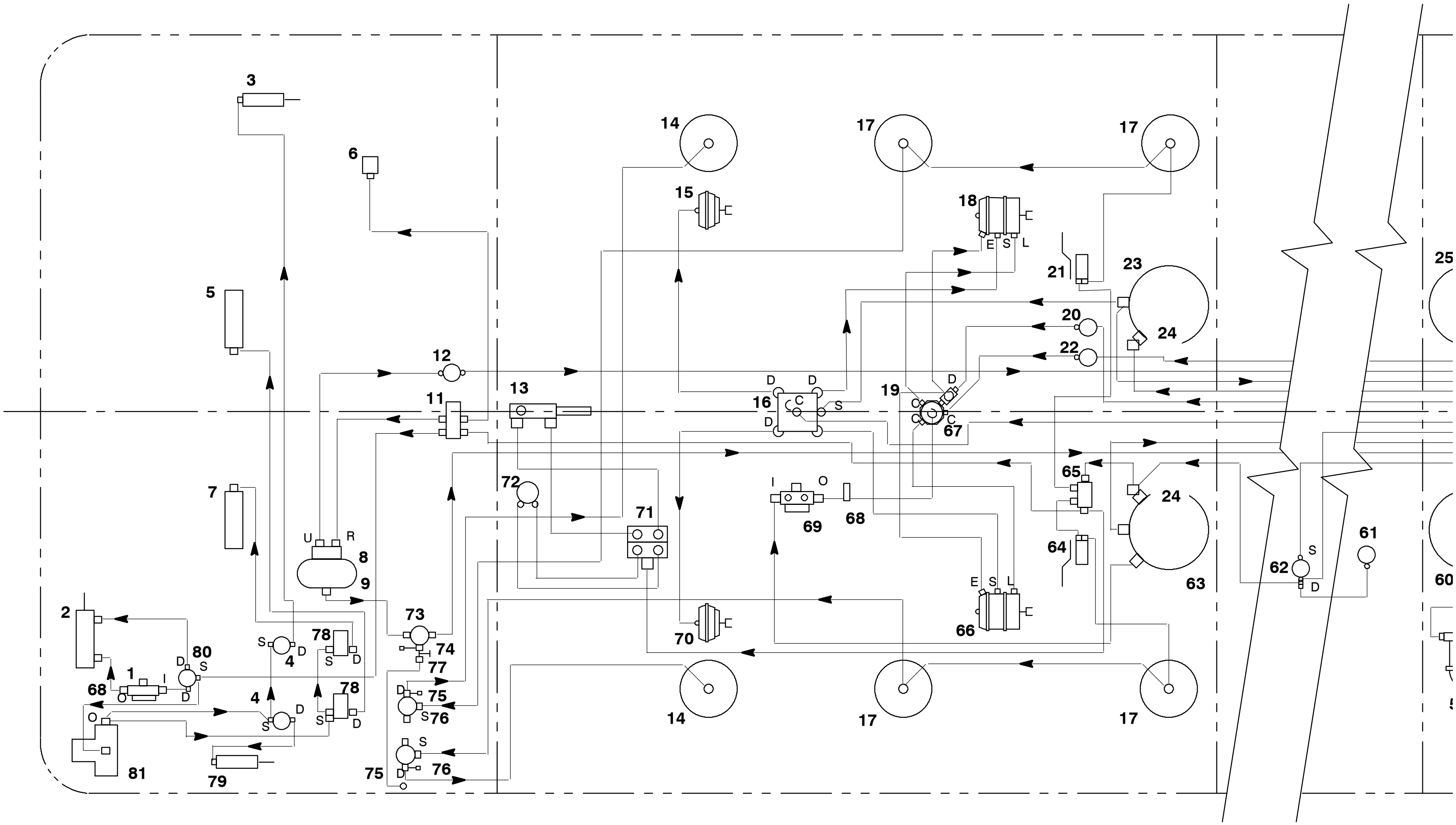
Defective cloth covered perforated plate in air dryer desiccant cartridge or improperly rebuilt desiccant cartridge
Compressor passing excessive oil
Faulty heater and thermostat, wiring, fuse not allowing purge (cold weather operation only)

16. Unable to Remove End Cover, or Unable to Install New Desiccant Cartridge

Result of reversing the inlet and outlet connections

17. Air Dryer End Cover Separates From Air Dryer Housing During Operation

Excessive system pressure built up within air dryer; caused by either plugged desiccant, check valve failure, frozen or obstructed discharge line (between air dryer and wet reservoir) or governor failure in conjunction with safety valve failure



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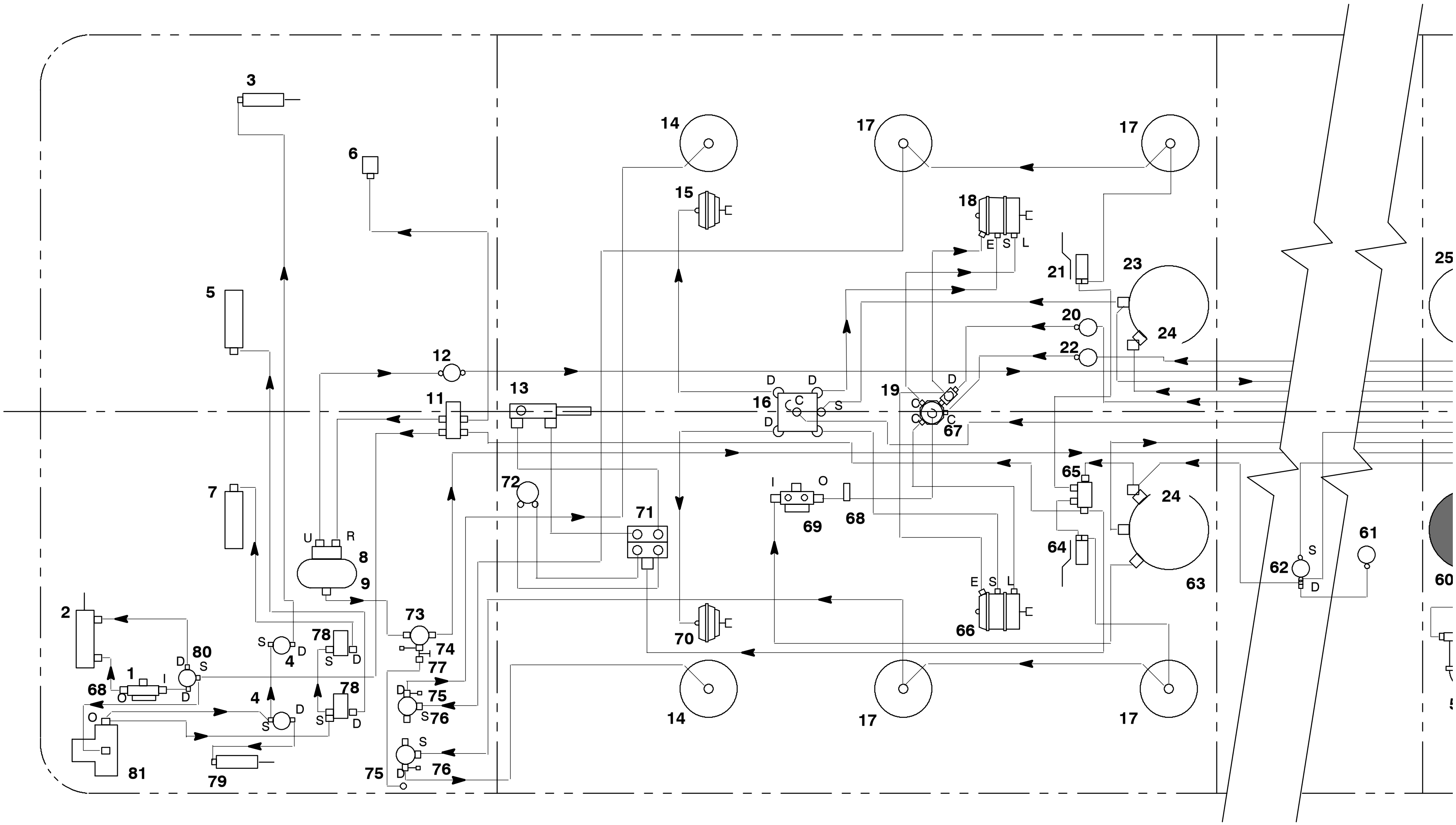
ITEM	DESCRIPTION
1	A/C BELT PRESSURE REGULATOR
2	A/C BELT TENSION CYLINDER
3	LH SHUTTER CYLINDER
4	SKINNER VALVE
5	LH ENGINE FAN CLUTCH
6	LOW AIR/ALTERNATOR CUTOUT SWITCH
7	RH ENGINE FAN CLUTCH
8	GOVERNOR
9	AIR COMPRESSOR
11	REAR ACCESSORY JUNCTION BLOCK

ITEM	DESCRIPTION
21	LH DRIVE LEVEL VALVE
22	EMERGENCY CONTROL DROP ELBOW
23	REAR SERVICE RESERVOIR
24	MAIN AIR CHECK VALVE
25	WET RESERVOIR
26	LH FRONT AXLE AIR SPRING
27	FRONT AXLE BRAKE CHAMBER LH
28	SMALL AIR CHECK VALVE
29	FRONT AXLE LEVEL VALVE
30	E–10 BRAKE VALVE

ITEM	DESCRIPTION
41	DUAL AIR GAUGE
42	WINDSHIELD WASHER CO
43	LH WIPER MOTOR/WASHE
44	WINDSHIELD WIPER CON
45	RH WIPER MOTOR/WASHI
46	ENTRANCE DOOR CYLIND
47	FRONT ACCESSORY JUNC
48	LOW AIR PRESSURE WAR
49	DOOR CLAW CYLINDER
50	RAM AIR SWITCH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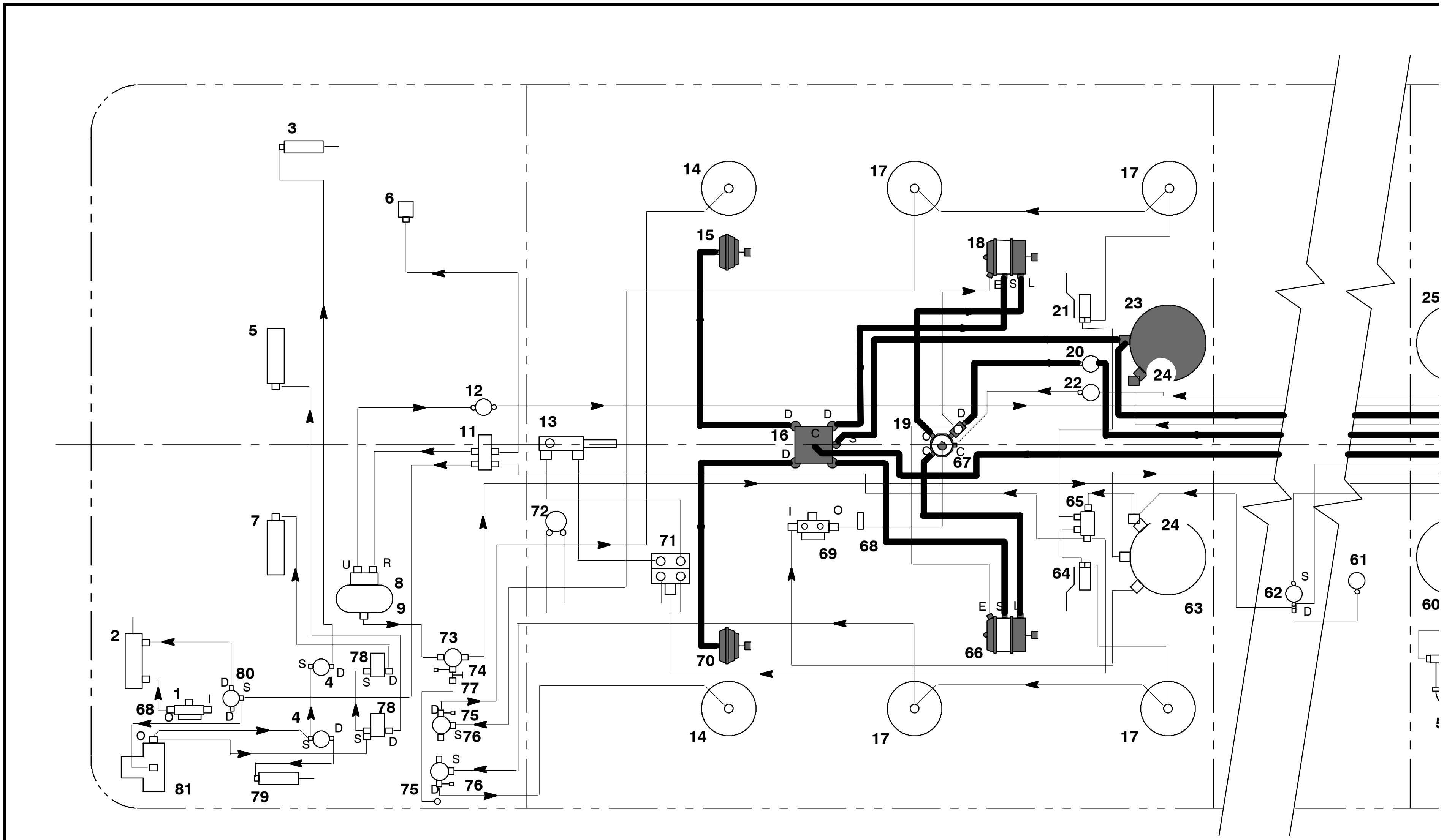
3	LH SHUTTER CYLINDER	23	REAR SERVICE RESERVOIR	43	LH WIPER MOTOR/WASH
4	SKINNER VALVE	24	MAIN AIR CHECK VALVE	44	WINDSHIELD WIPER CON
5	LH ENGINE FAN CLUTCH	25	WET RESERVOIR	45	RH WIPER MOTOR/WASH
6	LOW AIR/ALTERNATOR CUTOUT SWITCH	26	LH FRONT AXLE AIR SPRING	46	ENTRANCE DOOR CYLIN
7	RH ENGINE FAN CLUTCH	27	FRONT AXLE BRAKE CHAMBER LH	47	FRONT ACCESSORY JUN
8	GOVERNOR	28	SMALL AIR CHECK VALVE	48	LOW AIR PRESSURE WAR
9	AIR COMPRESSOR	29	FRONT AXLE LEVEL VALVE	49	DOOR CLAW CYLINDER
11	REAR ACCESSORY JUNCTION BLOCK	30	E–10 BRAKE VALVE	50	RAM AIR SWITCH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7	RH ENGINE FAN CLUTCH
8	GOVERNOR
9	AIR COMPRESSOR
11	REAR ACCESSORY JUNCTION BLOCK
12	DRYER UNLOAD DROP ELBOW

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25	WET RESERVOIR
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27	FRONT AXLE BRAKE CHAMBER LH
28	SMALL AIR CHECK VALVE
29	FRONT AXLE LEVEL VALVE
30	E–10 BRAKE VALVE
31	PARK EMERGENCY FILL VALVE

ITEM	DESCRIPTION
41	DUAL AIR GAUGE
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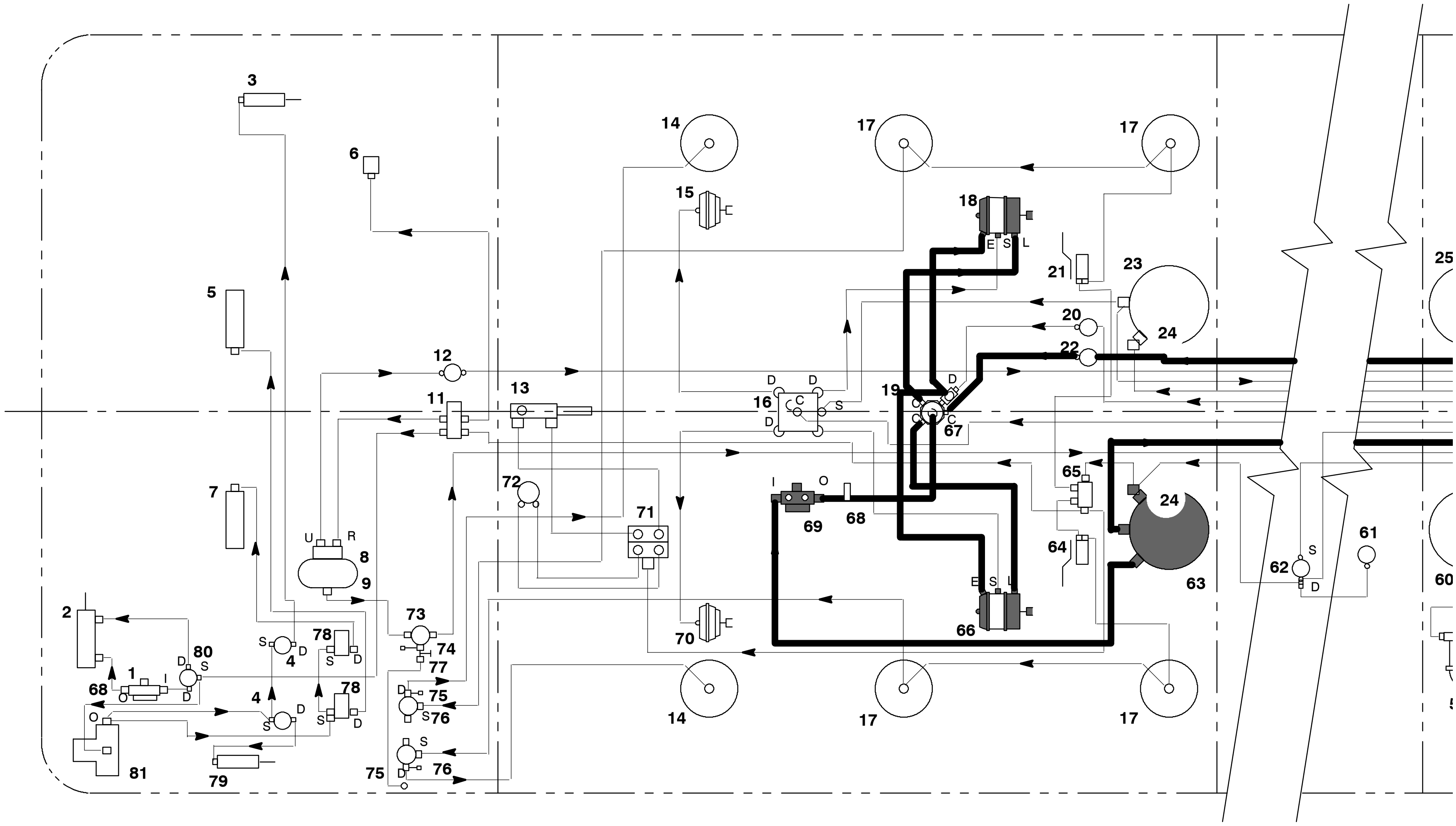
44	WINDSHIELD WIPER CON
45	RH WIPER MOTOR/WASH
46	ENTRANCE DOOR CYLIN
47	FRONT ACCESSORY JUN
48	LOW AIR PRESSURE WAR
49	DOOR CLAW CYLINDER
50	RAM AIR SWITCH
51	DOOR MANUAL SWITCH



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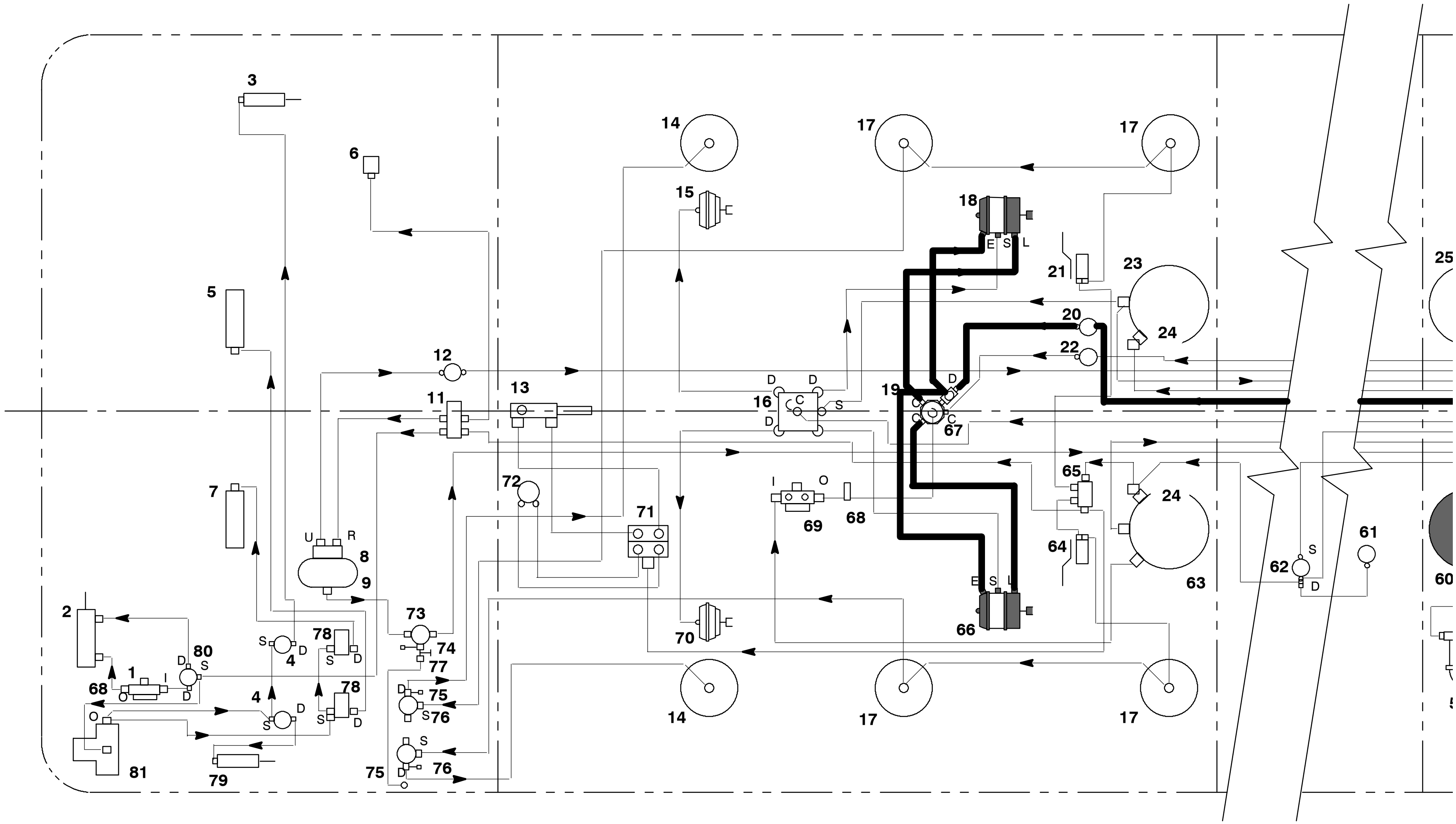

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
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4	SKINNER VALVE	24	MAIN AIR CHECK VALVE	44	WINDSHIELD WIPER CONTROL
5	LH ENGINE FAN CLUTCH	25	WET RESERVOIR	45	RH WIPER MOTOR/WASHER
6	LOW AIR/ALTERNATOR CUTOUT SWITCH	26	LH FRONT AXLE AIR SPRING	46	ENTRANCE DOOR CYLINDER/SOLENOID ASSEM
7	RH ENGINE FAN CLUTCH	27	FRONT AXLE BRAKE CHAMBER LH	47	FRONT ACCESSORY JUNCTION BLOCK
8	GOVERNOR	28	SMALL AIR CHECK VALVE	48	LOW AIR PRESSURE WARNING SWITCH
9	AIR COMPRESSOR	29	FRONT AXLE LEVEL VALVE	49	DOOR CLAW CYLINDER
11	REAR ACCESSORY JUNCTION BLOCK	30	E–10 BRAKE VALVE	50	RAM AIR SWITCH
12	DRYER UNLOAD DROP ELBOW	31	PARK EMERGENCY FILL VALVE	51	DOOR MANUAL SWITCH
13	TAG AXLE LATCH CYLINDER	32	REAR SERVICE EMERGENCY FILL VALVE	52	EMERGENCY STANDBY VALVE
14	TAG AXLE AIR SPRING	33	FRONT SERVICE EMERGENCY FILL VALVE	53	DOOR CLAW SOLENOID VALVE
15	LH TAG AXLE BRAKE CHAMBER	34	PRESSURE TEST FITTING	54	DOOR CONTROL QUICK RELEASE VALVE
16	R–14 RELAY	35	STOPLIGHT SWITCH	55	AD9 AIR DRYER

SECTION 4B

AD-9 AIR DRYER

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 4B-1
Operation 4B-1
Preventive Maintenance 4B-4
AD-9 Air Dryer Troubleshooting 4B-11

GENERAL DESCRIPTION

The AD-9 Air Dryer (Figure 1) collects and removes contaminants (solid, liquid and vapor form) in the air system before they enter the brake system. It provides clean, dry air to the components of the brake system which increases the life of the system and reduces maintenance.

The AD-9 Air Dryer consists of the desiccant cartridge and a die cast aluminum end cover secured to a cylindrical steel outer shell with eight capscrews and nuts. The end cover contains a check valve assembly, a safety valve, three threaded air connections and the purge valve housing assembly. The removable purge valve housing assembly incorporates a purge valve mechanism and a turbocharger cutoff feature that is designed to prevent loss of engine “turbo” boost pressure during the purge cycle. For ease of serviceability, the desiccant cartridge and discharge check valve assembly are screw-in type. The purge valve housing assembly includes the heater and thermostat assembly and the discharge check valve assembly. Both are serviceable from the exterior of the air dryer. Servicing the screw-in desiccant cartridge requires removal of the air dryer assembly from the coach.

The AD-9 has three female pipe thread air connections and each is identified as follows:

PORT ID	FUNCTION/CONNECTION
4-CON	Control Port (purge valve control and turbo cutoff)
11-SUP	Supply Port (air in)
2-DEL	Delivery Port (air out)

OPERATION

The AD-9 Air Dryer alternates between two operational modes or “cycles” during operation: the CHARGE CYCLE (Figure 2) and the PURGE CYCLE (Figure 3). The following descriptions are separated into these “cycles”.

CHARGE CYCLE

When the compressor is loaded (compressing air), compressed air, along with oil, oil vapor, water, and water vapor flow through the compressor discharge line to the supply port of the air dryer end cover. As air travels through the end cover assembly, its direction of flow changes several times, reducing the temperature, causing contaminates to condense and drop to the bottom (or sump), of the air dryer end cover.

After exiting the end cover, the air flows into the desiccant cartridge. In the desiccant cartridge, the air flows through an oil separator removing water in liquid form as well as oil, oil vapor, and solid contaminates.

The air exits the oil separator and enters the desiccant drying bed. Air flowing through the column of desiccant becomes progressively dryer as water vapor adheres to the desiccant material in a process known as ADSORPTION. The desiccant cartridge typically removes 95% of the water vapor from the pressurized air.

The majority of dry air exits the desiccant cartridge through its integral single check valve to fill the purge volume between the desiccant cartridge and outer shell. Some air will also exit the desiccant cartridge through the purge orifice adjacent to the check valve.

Dry air flows out of the purge volume through the single check valve assembly and out the delivery port to the first (supply) reservoir of the air system.

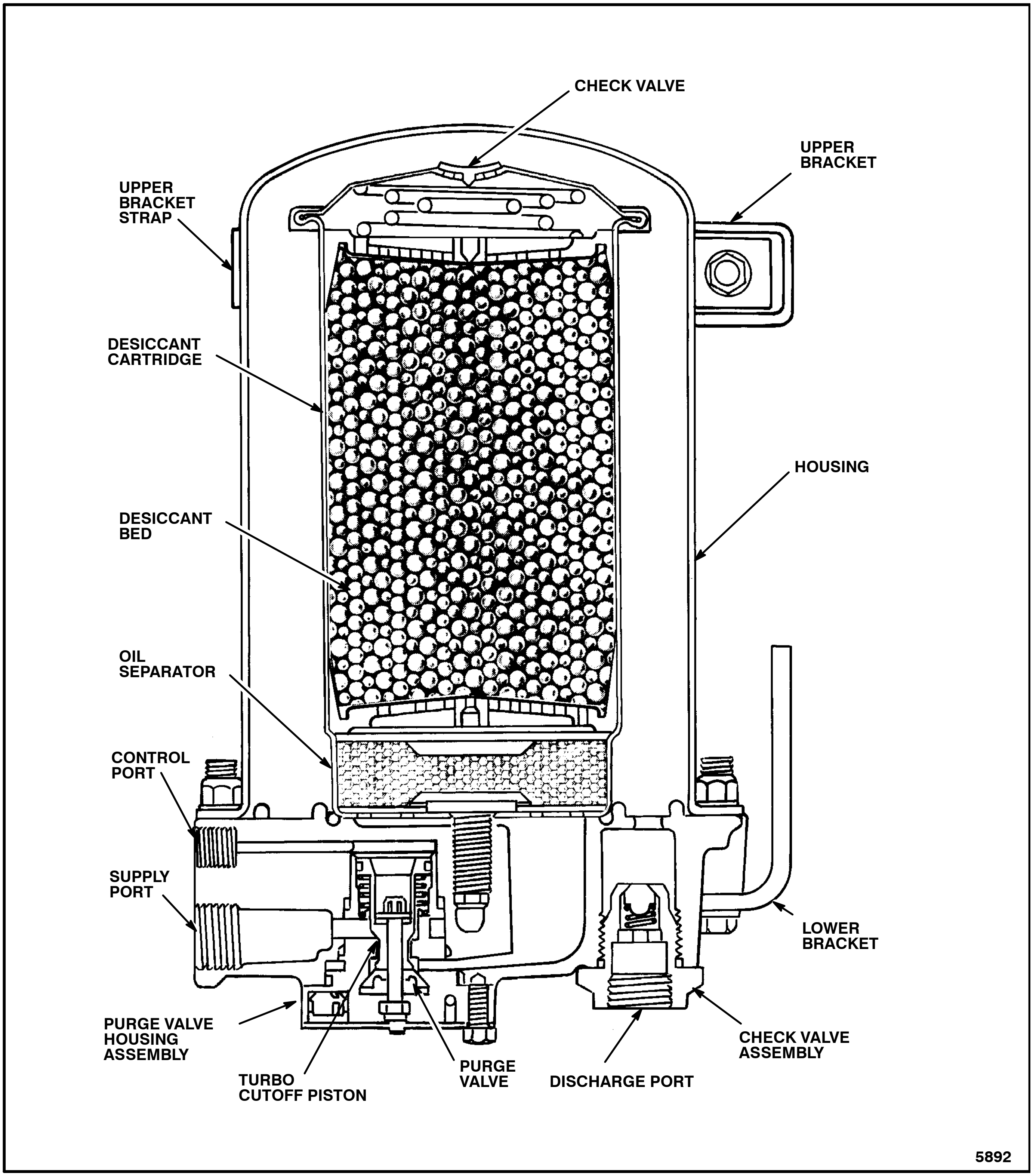
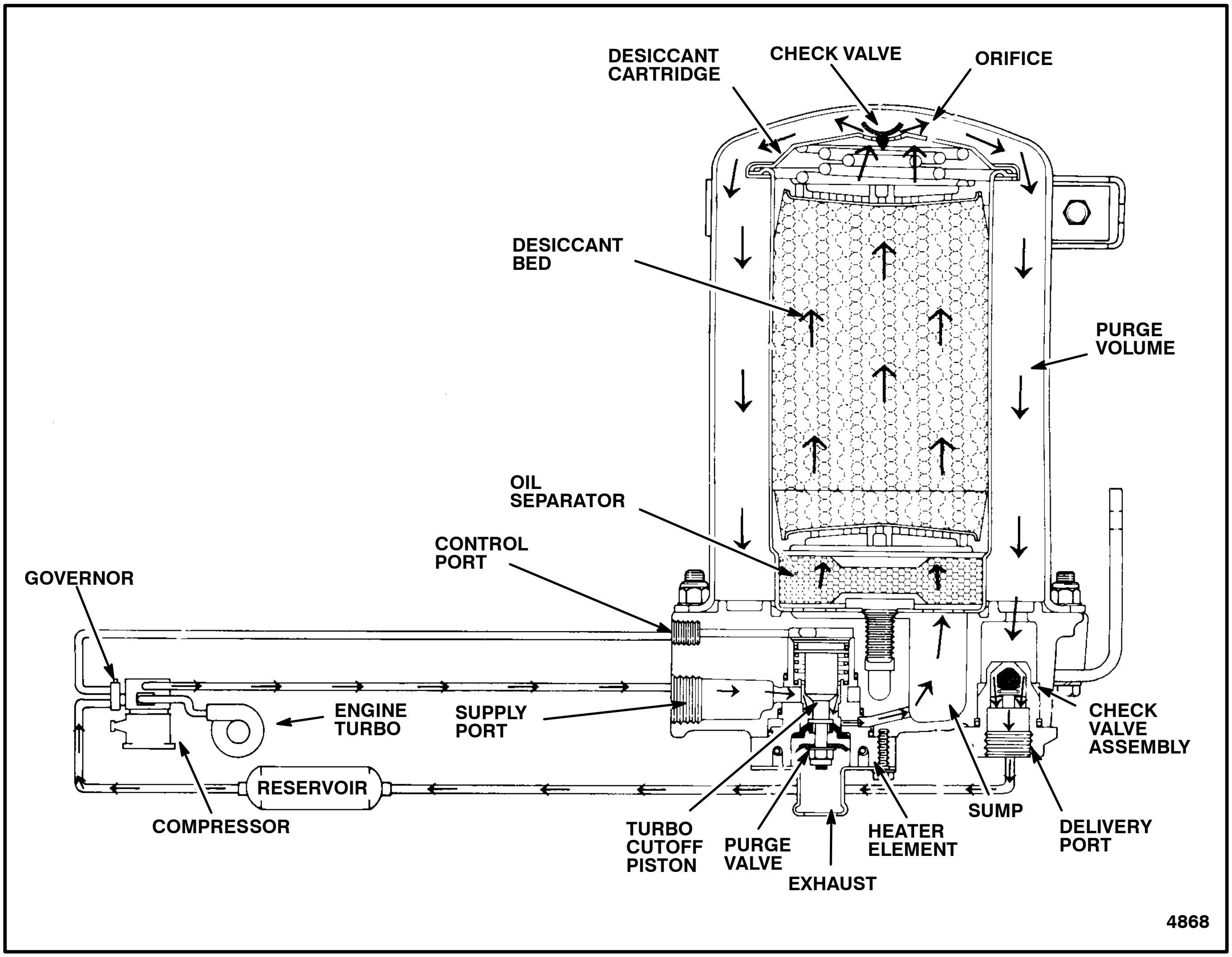

CHECK VALVE
UPPER BRACKET
UPPER BRACKET STRAP
DESICCANT CARTRIDGE
HOUSING
DESICCANT BED
OIL SEPARATOR
CONTROL PORT
SUPPLY PORT
LOWER BRACKET
PURGE VALVE HOUSING ASSEMBLY
CHECK VALVE ASSEMBLY
TURBO CUTOFF PISTON
PURGE VALVE
DISCHARGE PORT
5892

Figure 1. AD-9 Air Dryer Sectional View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DESICCANT BED
PURGE VOLUME
OIL SEPARATOR
CONTROL PORT
GOVERNOR
ENGINE TURBO
SUPPLY PORT
CHECK VALVE ASSEMBLY
RESERVOIR
COMPRESSOR
TURBO CUTOFF PISTON
PURGE VALVE
EXHAUST
HEATER ELEMENT
SUMP
DELIVERY PORT
4868

Figure 2. AD-9 Charge Cycle

The air dryer remains in the charge cycle until the air brake system pressure builds to the governor cutout setting.

PURGE CYCLE (FIGURE 3)

When the air brake system pressure reaches the governor cutout setting, the compressor unloads (air compression stops) and the purge cycle begins. When the governor unloads the compressor, it pressurizes the compressor unloader mechanism and the line connecting the governor unloader port to the AD-9 end cover control port. The purge piston moves in response to the air pressure, opening the purge valve to the atmosphere and (partially) closing off the air supply from the compressor. This will be further discussed in the section covering the turbo cutoff feature. Contaminants in the end cover sump are expelled immediately when the purge valve opens. Also, the air changes direction through the desiccant and begins to flow back through the desiccant toward the open purge valve. Oil and solid contaminants collected by the oil separator are removed by air flowing from the desiccant drying bed to the open purge valve.

The initial purge and desiccant cartridge decompression lasts only a few seconds and is evidenced by an audible burst of air at the AD-9 exhaust. The actual reactivation of the desiccant drying bed begins as dry air flows from the purge volume through the desiccant cartridge purge orifice and into the desiccant drying bed. Pressurized air from the purge volume expands after passing through the purge orifice; its pressure is lowered and its volume increased. The flow of dry air through the drying bed reactivates the desiccant material by removing the water vapor adhering to it. Generally, 15-30 seconds are required for the entire purge volume to flow through the desiccant drying bed.

The end cover single check valve assembly prevents air pressure in the brake system from returning to the air

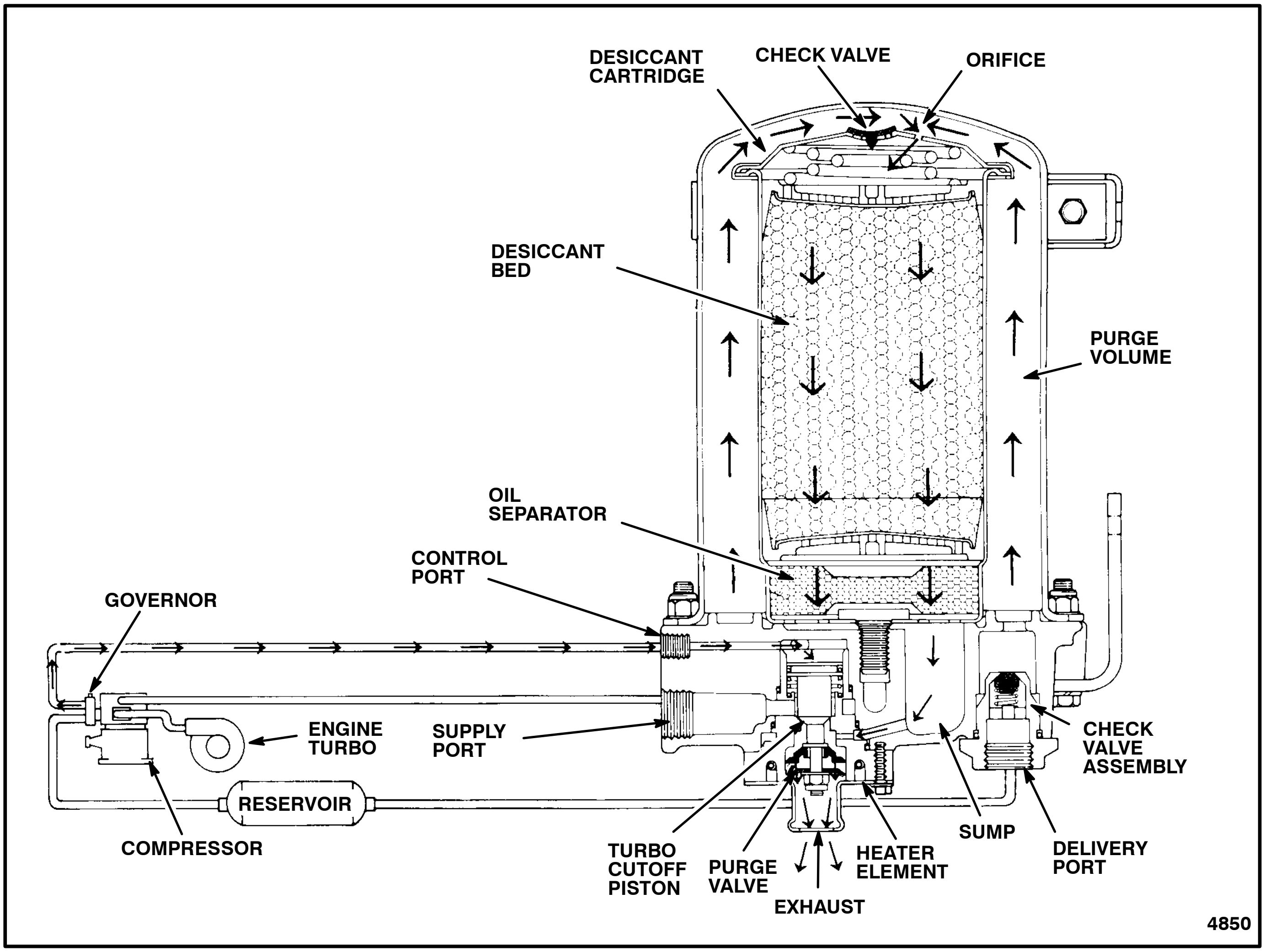

DESICCANT CARTRIDGE
CHECK VALVE
ORIFICE
DESICCANT BED
PURGE VOLUME
OIL SEPARATOR
CONTROL PORT
GOVERNOR
ENGINE TURBO
SUPPLY PORT
CHECK VALVE ASSEMBLY
RESERVOIR
COMPRESSOR
TURBO CUTOFF PISTON
PURGE VALVE
EXHAUST
HEATER ELEMENT
SUMP
DELIVERY PORT
4850

Figure 3. AD-9 Purge Cycle

dryer during the purge cycle. After the 30-second purge cycle is complete, the air dryer is ready for the next charge cycle.

The purge valve will remain open after the purge cycle is complete until the governor signals the compressor to charge.

TURBO CUTOFF FEATURE

The primary function of the turbo cutoff valve (Figure 4) is to prevent loss of engine turbocharger air pressure through the AD-9. At the onset of the purge cycle, the downward travel of the purge piston stops when the turbo cutoff valve contacts its mating metal seat in the purge valve housing. With the turbo cutoff valve seated, air in the discharge line and inlet port is restricted from entering the dryer. While the turbo cutoff effectively prevents loss of turbo charger boost pressure to the engine, some seepage of air may be detected under certain conditions of compressor and turbocharger operation. During these conditions low pressure will be trapped in the discharge line.

PREVENTIVE MAINTENANCE

Every 900 hours, 25,000 miles or 3 months.

1. Inspect for leaks.

2. Check for moisture in the air brake system by opening draincocks and checking for water. If moisture is present, the desiccant may require replacement. However, the following conditions may also cause water accumulation.

a. An outside air source has been used to charge the system. This air did not pass through the drying bed.

b. Air usage is exceptionally high and not normal. This may be due to accessory air demands or an unusual air requirement that does not allow the compressor to load and unload normally. Check for high air system leakage.

c. In areas where more than a 30-degree range of temperature occurs in one day, small amounts of water can collect in the air brake system due to condensation. Under these conditions, the presence of small amounts

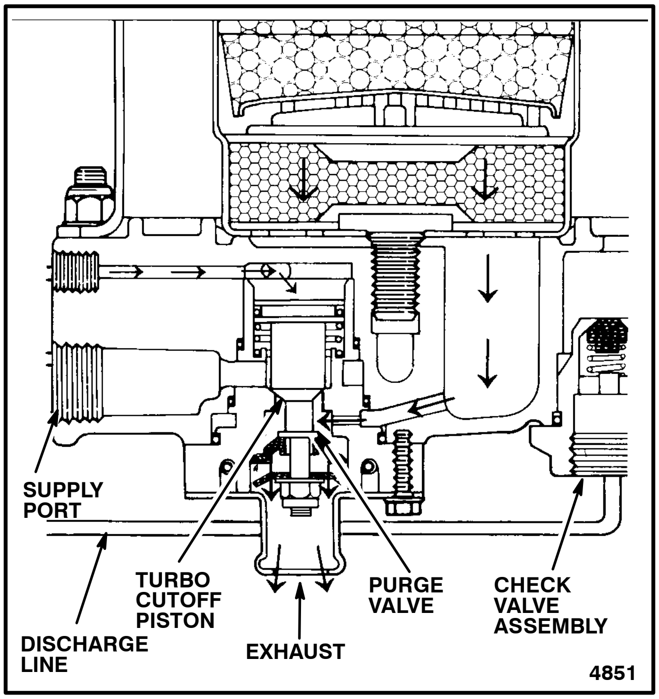


Figure 4. AD-9 Turbo Cutoff

of moisture is normal and should not be considered as a sign that the dryer is not performing properly.

NOTE: A small amount of oil in the system may be normal and should not be considered a reason to replace the desiccant; oil stained desiccant can function adequately.

3. Perform the OPERATION & LEAKAGE TESTS shown later in this section.

Every 10,800 hours, 300,000 miles or 36 months

1. Rebuild the air dryer and replace the desiccant cartridge.

2. Check mounting bolts for tightness. Retorque to 270-385 in-lbs (30.5-43.5 N·m).

OPERATION & LEAKAGE TESTS

1. Test the outlet port check valve by building the air system to governor cut-out and observing a test air gauge installed in the main air tank. Check all lines and fittings leading to and from the air dryer for leakage and integrity. A rapid loss of pressure could indicate a failed outlet port check valve. This can be confirmed by bleeding the system down, removing the check valve, applying air pressure to the delivery side of the check valve and applying a soap solution to the opposite side. Leakage should not exceed a 1-inch (25.4 mm) bubble in 5 seconds.

2. Check for excessive leakage around the purge valve. With the compressor loaded, apply a soap solution to the purge valve housing assembly exhaust port and see that leakage does not exceed a 1-inch (25.4 mm) bubble in 5 seconds. If leakage exceeds the maximum specified, service the purge valve housing assembly.

3. Close all air system drain cocks. Build up system pressure to governor cut-out and note that the dryer purges with an audible escape of air. “Fan” the service brakes to reduce system air pressure to governor cut-in. Note that the system once again builds full pressure and is followed by a dryer purge.

4. Check the operation of the safety valve by pulling the exposed stem while the compressor is loaded. There must be an exhaust of air while the stem is held and the valve should reseat when the stem is released. Refer to “Brake Valves and Switches” “Safety Valve”.

5. Check the operation of the end cover heater and thermostat assembly during cold weather operation as follows:

a. Electric Power to the Dryer (Figure 5)

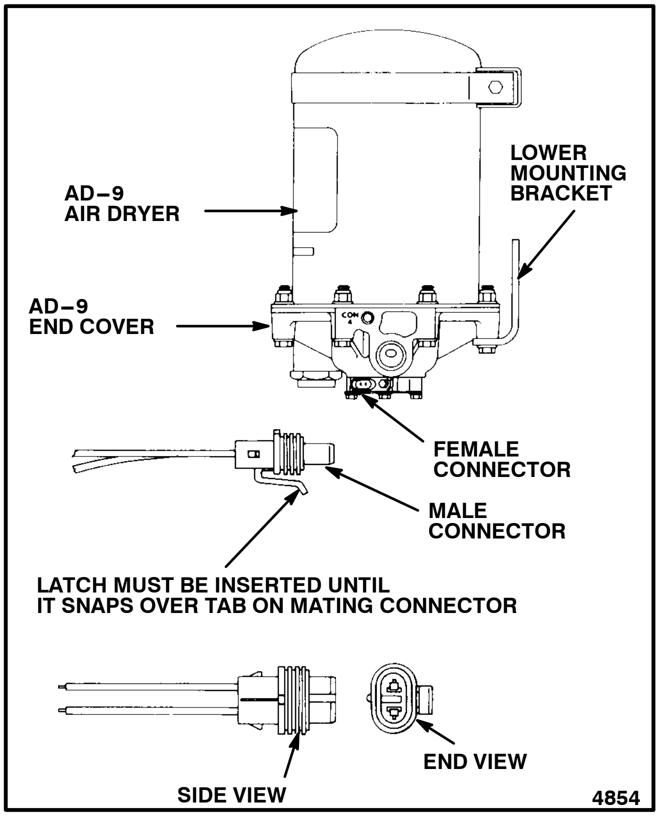


Figure 5. Heater and Thermostat Connector

With the engine run switch in the “ON” position, check for voltage at the heater and thermostat using a voltmeter or test light. Unplug the electrical connector at the air dryer and place the test leads on each of the pins of the male connector. If there is no voltage, look for an open circuit or corrosion on the circuit’s harness. Check to see if a ground exists.

b. Thermostat and Heater Operation

Rotate engine run switch to the "OFF" position. Cool the dryer end cover to below 40°F. Using an ohmmeter, check the resistance between the electrical pins in the female connector. The resistance should be 6.8-9.0 ohms for the 24-volt heater.

NOTE: If the resistance is higher than the maximum stated, replace the purge valve housing assembly. The assembly includes the heater and thermostat assembly.

Warm the end cover to 90°F and again check the resistance. The resistance should exceed 1000 ohms. If the resistance values are within these limits, the thermostat and heater assembly is working properly. If the resistance values are out of these limits, replace the purge valve housing which includes the heater and thermostat.

REBUILDING THE AD-9 AIR DRYER

General

If, after completing the routine operation and leakage tests, it has been determined that one or more parts of the air dryer require replacement or maintenance, refer to the following list to find the right kit for the repair.

When rebuilding or replacing parts of the air dryer, use only genuine Bendix parts. Remove the air dryer whenever servicing the desiccant cartridge.

Maintenance Kits

PURGE VALVE HOUSING MAINTENANCE KIT

This kit contains the parts necessary to rebuild the air portion of the purge valve housing. It DOES NOT include the heater and thermostat assembly.

DESICCANT CARTRIDGE REPLACEMENT KIT

This kit contains the parts necessary to change the desiccant cartridge only.

REMANUFACTURED DESICCANT CARTRIDGE REPLACEMENT KIT

This kit contains the parts necessary to change the desiccant cartridge only.

END COVER CHECK VALVE ASSEMBLY REPLACEMENT

This contains the ¾-inch thread size check valve assembly. Specify the thread size when ordering this kit.

SERVICE NEW OR REMANUFACTURED EXCHANGE PURGE VALVE HOUSING ASSEMBLY

This kit includes purge valve housing with heater and thermostat for the 24-volt systems. Specify the voltage rating on the old unit when ordering this kit.

COMPLETE MOUNTING BRACKET KIT

This kit contains the upper and lower brackets as well as the mounting hardware items to mount them.

⚠ CAUTION ⚠

When working on or around the bus, follow these general safety precautions:

1. Stop the engine when working around the bus. When circumstances require that the engine be operating, USE EXTREME CAUTION to prevent personal injury from contact with moving, rotating, leaking, heated, or electrically charged parts.

2. Drain the air pressure from all reservoirs before beginning any work on the bus.

3. Disconnect the batteries at the battery disconnect switches when not operating the engine or inspecting the electrical system.

4. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a part or plug unless you are sure all system pressure has been depleted.

5. Never exceed recommended pressures and always wear safety glasses.

6. Do not try to install, remove, disassemble, or assemble a part until you have read and thoroughly understand the recommended procedures. Use only the proper tools and follow all precautions for those tools.

7. Use only Bendix replacement parts, subassemblies, and kits. Replacement hardware, tubing, hose, fittings, etc., should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.

8. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted.

9. Make sure all parts and systems are restored to their proper operating condition before returning the bus to service.

DRYER REMOVAL

1. Park the bus on a level surface and chock and block the wheels.
2. Drain ALL reservoirs to 0 psi (0 kPa).

CAUTION

Compressor discharge line may still contain residual pressure.

3. Identify and remove the three air lines from the end cover and note the position of the end cover ports relative to the bus.

4. Unplug the harness from the heater and thermostat connector.

5. Loosen the 5/16 x 4½ inch bolt securing the upper mounting strap.

6. Remove fasteners and mark the two ⅜-inch end cover capscrews, locknuts, and four special washers that retain the lower mounting bracket to the end cover. Also, mark these two holes in the end cover. These bolts are longer than the others.

7. Remove the dryer from the mounting brackets.

DISASSEMBLY

The following disassembly and assembly procedure is presented for reference purposes and presupposes that a major rebuild of the dryer is being undertaken. Several replacement parts and maintenance kits are available which do not require complete disassembly of the dryer. The instructions provided with these parts and kits should be followed in lieu of the instructions printed here.

CAUTION

While performing service on the dryer, it is not recommended that a clamping device be used to hold any die cast aluminum component as damage may result. To hold the end cover, install a pipe nipple in the supply port and clamp the nipple into a vise.

1. Using an adjustable wrench or a 1¾-inch socket, remove the delivery check valve assembly (15) and O-ring (1) (Figure 6). Remove the O-ring from the check valve assembly.

2. Remove the three ¼-inch self-tapping screws (3) securing the purge valve housing assembly to the end cover assembly. Pull the purge valve housing assembly out of the end cover assembly. Remove the three O-rings (5, 6, and 7) from the exterior of the purge valve housing assembly.

NOTE: O-rings 5 and 6 may be lodged in the end cover bores, if so, they must be removed.

3. Disassemble purge valve housing assembly.

NOTE: Usually, a flat (non-extended) exhaust cover (30) is used. This cover should be left intact while servicing the purge valve housing assembly. However, if an extended type exhaust is used to accommodate the attachment of an exhaust hose, the cover must be carefully peeled off the purge valve housing. USE A THIN FLAT BLADE TO PRY THE EXHAUST COVER OFF, TAKING CARE NOT TO DAMAGE THE POTTING MATERIAL (RTV SEALANT) UNDER THE COVER. To remove the piston from the purge valve housing assembly requires a special Torx head socket or a twelve point ¼-inch socket to hold the head of the purge valve bolt (31).

a. Remove the ¼-inch nut (4) from the bottom of the purge valve housing assembly using a 9/16-inch socket wrench and a Torx head socket to hold the head of the bolt (31). Remove the diaphragm washer (32), if present, and the diaphragm (2), if present, and the purge valve (11) from the purge valve housing.

b. Remove the ¼-inch Torx head bolt (31) from the opposite end, then the purge piston (33), the return spring (13), and two O-rings (10 and 14). One O-ring is on the outside and the other is on the inside of the purge piston.

c. Heater and Thermostat Assembly

CAUTION

Do not try to remove this assembly. Removal will damage this part and it is NOT AVAILABLE AS A SERVICE PART. If the heater and thermostat are defective, replace the entire purge valve housing assembly which includes these items.

4. Remove the remaining six ⅜-inch capscrews (16), lock nuts (19), and twelve special washers (17) that secure the end cover to the housing (24). Separate the end cover and desiccant cartridge (22) from the housing (24).

5. Remove the end cover to outer housing O-ring (23).

6. Do not remove the safety valve from the end cover unless it is defective. If replacement is required, apply thread sealant or Teflon tape on the threads of the replacement valve and torque to 120-400 in-lbs (13.6-45.2 N·m). Make sure the drain hole is facing down.

7. Place a strap or chain wrench around the desiccant cartridge (22) so it is about 2-3 inches away from the end cover. Rotate the cartridge counterclockwise until it completely separates from the end cover.

NOTE: A torque, up to 50 ft-lbs (67.8 N·m), may be required to perform this disassembly.

8. Remove the desiccant cartridge O-ring (21) from the end cover.

CLEANING AND INSPECTION

1. Using mineral spirits or an equivalent solvent, clean and **thoroughly dry** all metal parts.

2. Inspect the interior and exterior of all metal parts that will be reused for severe corrosion, pitting, and cracks. Superficial corrosion and pitting on the **exterior** portion of the upper and lower body halves is acceptable.

3. Inspect the bores of both the end cover and the purge valve housing for **deep** scuffing or gouges.

4. Make certain that all purge valve housing and end cover passages are open and free of obstructions.

5. Inspect the pipe threads in the end cover. Make certain they are clean and free of thread sealant.

6. Inspect the purge valve piston seat for excessive wear.

7. Inspect the purge valve housing bore and seats for excessive wear and scuffing.

8. Inspect all air line fittings for corrosion. Clean all old thread sealant from the pipe threads.

9. Discard all removed O-rings and replace with new O-rings from the appropriate kit.

Replace any part showing a condition as described in steps 1-9.

ASSEMBLY

Before assembly, coat all O-rings, O-ring grooves, and bores with a generous amount of barium base lubricant. Refer to Figure 6 during assembly unless otherwise advised.

1. Assemble Purge Valve Housing

A. Install the O-ring (14) in its groove on the OD of the purge piston. Place the spring (13) in the bore of the purge valve housing. Place the O-ring (10) into its recess in the bore of the purge piston. Install the ¼-inch Torx head bolt (31) into the ID of the purge piston. Insert the purge piston (33) into the ID of the spring (13). Using a Torx head wrench on the head of the bolt, push the piston into the valve housing until it bottoms.

B. While depressing the purge piston with the Torx wrench, install the following parts over the purge valve bolt (31) from the opposite end of the purge valve housing. Install the purge valve (11) with its rubber side first, followed by the diaphragm (2) if present, and the diaphragm washer (32) if present or the flatwasher and finally the ¼-inch hex nut (4). Torque the purge valve nut and bolt (4 and 31) to 60-80 in-lbs (6.8-9 N·m).

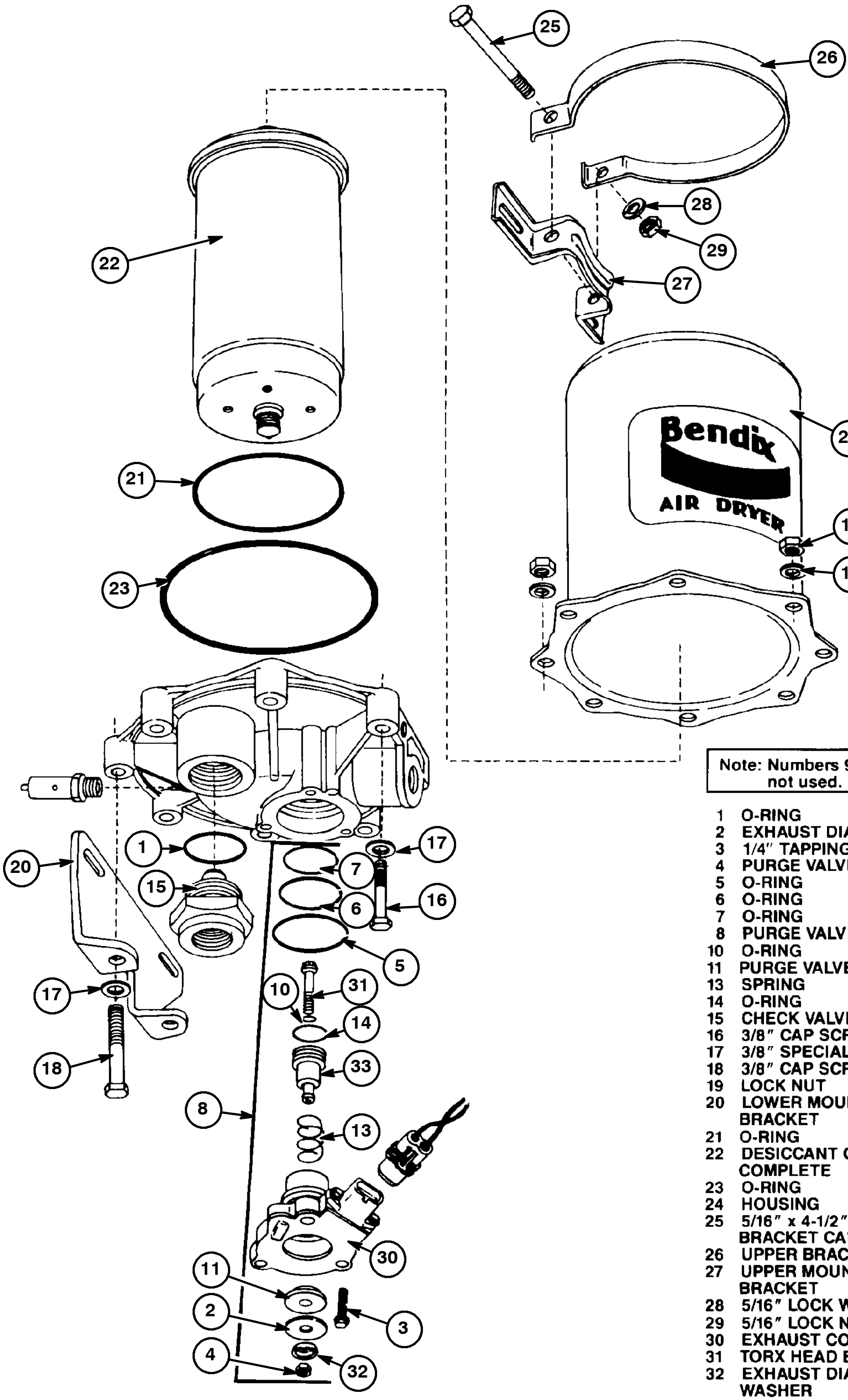
C. Install the three O-rings (5, 6, and 7) on the purge valve housing placing each in its appropriate location. If the exhaust cover (30) was removed during disassembly, install it on the purge valve housing assembly making certain the “bubble” portion is positioned over the thermostat. Install the assembled purge valve housing in the end cover making certain to orient both parts so the connector is about 10 degrees clockwise from the supply port, while making sure the housing is fully seated against the cover. Secure the housing to the cover using the three ¼-inch self-tapping screws (3). Start all three screws by hand then torque to 85-125 in-lbs (9.6-14.1 N·m).

2. Install the O-ring (1) on the check valve assembly (15). Then, install the assembly in the end cover using a 1¾-inch socket. Torque to 200-250 in-lbs (22.6-28.2 N·m).

3. Install the desiccant O-ring (21) in its groove in the end cover. Using a light coat of barium grease, lubricate the bottom of the desiccant cartridge in the area that will contact the O-ring (21) and the end cover. Screw the cartridge into the end cover until contact is made between it and the O-ring. Using a strap or chain wrench positioned about 2-3 inches from the bottom of the cartridge, turn the desiccant cartridge clockwise 180-225 degrees beyond the position where initial contact was made between the cartridge and end cover O-ring. Torque should not exceed 50 ft-lbs (67.8 N·m).

4. Install the end cover outer housing O-ring (23) on the shoulder in the end cover. Place the housing (24) over the desiccant cartridge and align the holes. Install the six ⅜-inch capscrews (16), locknuts (19), and twelve special washers (17) making sure they are in the proper position as marked during disassembly. The two longer capscrews (18) will be used to secure the dryer to the mounting bracket. Tighten the six capscrews and nuts in a star pattern, depending on lower bracket location. (Figure 7) Torque to 270-385 in-lbs (30.5-43.5 N·m).

NOTE: The two remaining bolt holes in the end cover and the two remaining ⅜ inch bolts must be the ones marked during disassembly to assure proper orientation of the ports and adequate length of the capscrews.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Bendix
AIR DRYER
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32

Note: Numbers 9 and 12 not used.

1	O-RING
2	EXHAUST DIAPHRAGM
3	1/4″ TAPPING SCREW
4	PURGE VALVE LOCK NUT
5	O-RING
6	O-RING
7	O-RING
8	PURGE VALVE ASSEMBLY
10	O-RING
11	PURGE VALVE
13	SPRING
14	O-RING
15	CHECK VALVE ASSEMBLY
16	3/8″ CAP SCREW
17	3/8″ SPECIAL WASHER
18	3/8″ CAP SCREW (LONG)
19	LOCK NUT
20	LOWER MOUNTING BRACKET
21	O-RING
22	DESICCANT CARTRIDGE COMPLETE
23	O-RING
24	HOUSING
25	5/16″ x 4-1/2″ UPPER BRACKET CAP SCREW
26	UPPER BRACKET STRAP
27	UPPER MOUNTING BRACKET
28	5/16″ LOCK WASHER
29	5/16″ LOCK NUT
30	EXHAUST COVER
31	TORX HEAD BOLT
32	EXHAUST DIAPHRAGM WASHER
33	PURGE PISTON

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Figure 6. AD-9 Air Dryer Assembly

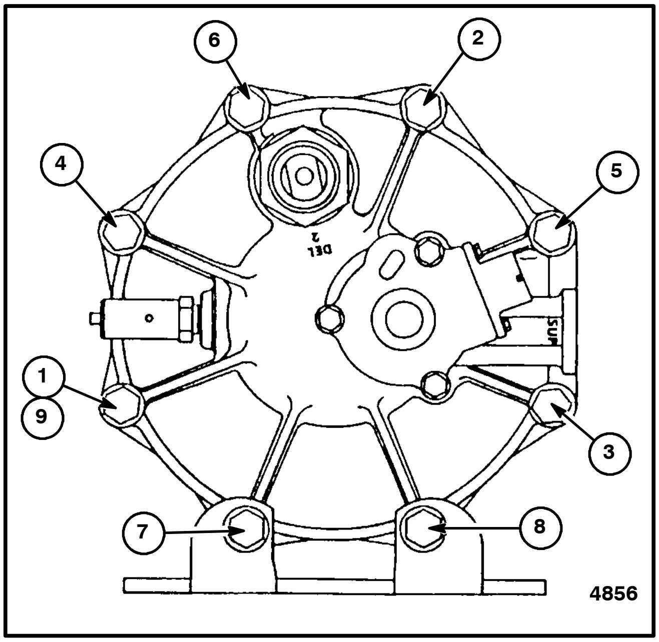

Figure 7. End Cover to Housing Torque Pattern

INSTALLATION

1. Install the assembled dryer onto the vehicle by slipping it into the upper mounting bracket. Align the two mounting holes in the end cover with the lower mounting bracket, so the bottom bracket supports the dryer. The end cover should rest on the bracket. Using the remaining ⅜-inch capscrews (18), four special washers (17), and two locknuts (19), secure the dryer to the lower bracket. Tighten, then torque the two remaining capscrews to 270-385 in-lbs (30.5-43.5 N·m).
2. Tighten the bolt and nut on the upper mounting bracket. Torque to 80-120 in-lbs (9.0-13.6 N·m).
3. Connect the three air lines to the dryer.
4. Connect the harness to the dryer heater and thermostat. Be sure the lock tab snaps in place.
5. Perform the OPERATION AND LEAKAGE tests, shown earlier in this section, before returning the coach to service.

AD-9 AIR DRYER TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Dryer is constantly "cycling" or purging.	A. Excessive system leakage.	A. Test for excessive system leakage. Allowable leakage: 1 psi/minute per service reservoir.
	B. Excessive leakage in fittings, hoses and tubing connected to the compressor, air dryer and wet reservoir.	B. Using a soap solution, test for leakage at fittings, drain valve and safety valve. Repair or replace as necessary.
	C. Defective check valve assembly in air dryer end cover.	C. Remove check valve assembly from the end cover. Apply air pressure to the delivery side of valve and a soap solution to the opposite end. Check for leakage. Permissible leakage is a 1 inch bubble in five seconds. If the leakage is excessive, replace check valve assembly.
	D. Defective governor.	D. Test the governor for the proper cut-in and cut-out pressures and excessive leakage in both positions.
	E. Leaking purge valve housing assembly and/or O-rings in air dryer end cover.	E. With the supply port open to atmosphere, apply 120 psi at the control port. Apply a soap solution to the supply port and exhaust port (purge valve seat area). Permissible leakage is a 1 inch bubble in five seconds.
	F. Compressor unloader leaking excessively.	F. Remove air strainer or fitting from compressor inlet cavity. With compressor unloaded check for unloader piston leakage. Slight leakage permissible.
2. Water in reservoirs.	A. Desiccant requires replacement - excessive contaminants in desiccant cartridge assembly.	A. Replace desiccant cartridge.
	B. Air system charged from outside source (outside air not passing through air dryer).	B. If system must have outside air fill provision, outside air should pass through an air dryer. This practice should be minimized.
	C. Air dryer not purging (See Symptom #5).	C. See cause and remedy for Symptom #5.
	D. Purge time insufficient due to excessive system leakage (see causes for Symptom #1).	D. Check causes and remedies for Symptom #1.

AD-9 AIR DRYER TROUBLESHOOTING (Contd.)

	E. Excessive air usage - Air dryer application requires additional purge volume.	E. Charge Cycle Time - The AD-9 is designed to provide clean, dry air for the brake system. When the air system is used to operate non-brake air accessories, it is necessary to determine that during normal, daily operation the compressor should recover from governor "cut-in" to governor "cut-out" in 90 seconds or less. If recovery time consistently exceeds this limit, it may be necessary to "bypass" the air accessory responsible for the high air usage. Purge Cycle Time - During normal vehicle operation, the air compressor must remain unloaded for a MINIMUM OF 20 SECONDS. The minimum purge time is required to ensure complete regeneration of the desiccant material.
	F. Air by-passes desiccant cartridge assembly.	F. Replace desiccant cartridge/end cover O-ring.
	G. Purge time is significantly less than minimum allowable.	G. Replace desiccant cartridge/end cover O-ring. Check to make sure desiccant cartridge assembly is properly installed. Replace desiccant cartridge assembly.
3. Safety valve on air dryer "popping off" or exhausting air.	A. Desiccant cartridge plugged.	A. Check compressor for excessive oil passing and/or correct compressor installation. Repair or replace as necessary. Rebuild or replace cartridge.
	B. Defective discharge check valve in end cover.	B. Test to determine if air is passing through check valve. Repair or replace.
	C. Defective fittings, hose or tubing between air dryer and first reservoir.	C. Check to determine if air is reaching first reservoir. Inspect for kinked tubing or hose. Check for undrilled or restricted hose or tubing fittings.
	D. Excessive pressure pulsations from compressor.	D. Increase volume in discharge line. Added length or size of line or add a ping tank.
	E. Safety valve setting lower than the maximum system pressure.	E. Reduce system pressure or obtain a higher setting safety valve.
4. Constant exhaust of air at air dryer purge valve exhaust or unable to build system pressure. (Charge mode.)	A. Air dryer purge valve leaking excessively.	A. With compressor loaded, apply a soap solution on the purge valve exhaust to test for excessive leakage. Repair purge valve as necessary.

AD-9 AIR DRYER TROUBLESHOOTING (Contd.)

	B. Defective governor.	B. Check governor for proper "cut-in", "cut-out" pressure and excessive leakage in both positions. Repair or replace as necessary.
	C. Purge control line connected to reservoir or exhaust port of governor.	C. Purge control line must be connected to unloader port of governor.
	D. Purge valve frozen open - faulty heater and thermostat, wiring, blown fuse.	D. Test heater and thermostat as described in Step 7 of Preventive Maintenance Section.
	E. Inlet and outlet air connections reversed.	E. Compressor discharge to inlet port. Reconnect lines properly.
	F. Kinked or blocked (plugged) discharge line.	F. Check to determine if air passes through discharge line. Check for kinks, bends, excessive carbon deposits.
	G. Excessive bends in discharge line (water collects and freezes).	G. Discharge line should be constantly sloping from compressor to air dryer with as few bends as possible.
	H. Excessive system leakage.	H. See Symptom #1's Causes and Remedies.
	I. Purge valve stays open - supply air leaks to control side.	I. Replace purge valve housing assembly O-rings.
5. Air dryer does not purge or exhaust air.	A. Broken, kinked, frozen, plugged or disconnected purge control line.	A. Test to determine air flows through purge control line when compressor is unloaded. Check for undrilled fittings. (See Symptom #4, Remedy C.)
	B. See Causes B, E, G for Symptom #4.	B. Refer to Remedies B, E, G for Symptom #4.
6. Desiccant material being expelled from air dryer purge valve exhaust (may look like whitish liquid or paste or small beads). - OR - Unsatisfactory desiccant life.	A. This symptom is almost always accompanied by one or more of Symptoms 1, 2, 3, 4 and 5. See related causes for these symptoms.	A. See Causes and Remedies for Symptoms 1, 2, 3, 4 and 5.
	B. Air dryer not securely mounted (excessive vibration).	B. Vibration should be held to minimum. Add bracket supports or change air dryer mounting location if necessary.
	C. Defective cloth covered perforated plate in air dryer.	C. Replace desiccant cartridge assembly.

AD-9 AIR DRYER TROUBLESHOOTING (Contd.)

	D. Compressor passing excessive oil.	D. Check for proper compressor installation; if symptoms persist, replace compressor.
	E. Desiccant cartridge not assembled properly to end cover (loose attachment).	E. Check the torque on the desiccant cartridge to end cover attachment. Refer to “assembly” section.
7. Constant seepage of air at air dryer purge valve exhaust (non-charging mode).	A. Inlet of air compressor pressurized by turbocharger from engine.	A. Some leakage of pressure past the metal seat of the turbo cutoff feature is to be expected, also may be audible. This slight loss of air will not affect the engine or turbo performance.
	B. Defective check valve assembly in air dryer end cover.	B. Refer to Remedy C, Symptom #1.

SECTION 4C1

DRUM BRAKES

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BRAKE ASSEMBLY - CAM-MASTER® W-SERIES

GENERAL DESCRIPTION

The Cam-Master® W-series brakes are air-operated, cam-actuated, dual shoe heavy-duty internal expanding drum type brakes. The brake assemblies are mounted at the wheel ends of each axle. The brake assemblies are sized (diameter and width) specifically to each axle brake specification. These brake assemblies feature all metal construction, and non-asbestos linings for long service life.

COMPONENTS

The W-series drum brake assembly contains several major components. All of these major components will be discussed, and some other related parts such as the brake drums will also be addressed.

LINING

The linings are made of high-friction composite type materials for superior coach braking performance. The brake linings are the components most likely to require servicing. Two (2) bolt-on lining pads are required for each brake shoe.

BRAKE SHOE

The two (2) brake shoes are positioned around the inner diameter of the brake drum. The shoes are anchored at one end with straight or taper pins to allow hinge type action, while the other end is fitted with a camshaft roller or follower. The brake shoes are retracted to their normal position by the brake return spring attached to both shoes.

SPIDER

The steel spider assembly holds the brake shoes and components in position at all times, and is the only brake component rigidly attached to the axle. The spider provides mounting holes for brake shoe anchor pins, camshaft actuator and attaching bolts.

Depending on the axle installation, the spider may contain various bushings and grease seals related to integral camshaft mounting. Other installations may require the addition of an extension bracket attached to the rear of the spider to accommodate longer camshafts and/or mounting of the brake chamber.

CAMSHAFT

One camshaft actuator is required per brake assembly, and rotates inside the spider or camshaft bracket. The camshaft design allows connection of the slack adjuster to the splined end, while the cam head end allows both brake shoe rollers to be positioned for actuation. Related serviceable components of the camshaft are the cam bushings and seals.

BRAKE DRUM

The brake drums are designed to allow the brake shoe linings to ride against the inside circumference while being actuated. The drums on the front, trailing and rear axles are of different width, and the front axle drums are balanced. The following chart shows the width of each drum and the location of use.

FRONT	14.5" x 6"
REAR	14.5" x 10"
TRAILING	14.5" x 5"

OPERATION

During service brake application, air flows to the brake chamber forcing the push rod to extend. The push rod is attached to the slack adjuster arm, and causes the slack adjuster to rotate, thereby making the camshaft rotate. As the camshaft head turns, the roller or cam follower rides up each cam and moves the brake shoes apart. When the shoes move apart, the linings contact the inner brake drum surface and create friction and stop the coach.

NOTE: Depending on axle installation camshaft rotation could be clockwise or counter-clockwise.

MAINTENANCE

⚠ WARNING ⚠

The composition of non-asbestos brake linings may contain glass, mineral wool, aramid, ceramic or carbon fibers. Long-term exposure to these types of fibers may cause pneumoconioses, fibrosis and/or cancer. Use caution to avoid the dust from the non-asbestos brake linings when working on them.

The guidelines listed below should be followed to minimize exposure to non-asbestos brake lining dust and particles.

1. Whenever possible, work on brakes in a separate area away from other operations.

2. Always wear a respirator approved by NIOSH or MSHA during all brake service procedures. Wear the respirator from the removal of the wheels through assembly.

3. Never use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends using cylinders that enclose the brake. These cylinders have vacuums with high-efficiency (HEPA) filters with arm sleeves. If such equipment is not available, carefully clean parts and assemblies in the open air.

4. Clean brake parts and assemblies in the open air. During disassembly, carefully place all parts on the floor to avoid getting dust into the air. Use an industrial vacuum cleaner with a HEPA filter system to clean dust from brake drums, backing plates and other brake parts. After using the vacuum, remove any remaining dust with a rag soaked in water and wrung nearly dry.

5. If it is necessary to grind or machine brake linings, additional precautions should be taken because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, such work should be done in an area with exhaust ventilation.

6. When cleaning the work area, never use compressed air or dry sweeping. Use an industrial vacuum cleaner with a HEPA filter and rags soaked in water and wrung nearly dry. Used rags should be disposed of with care to avoid getting dust into the air. Use an approved respirator while emptying vacuum cleaners and handling used rags.

7. After working on the brake system, workers should wash their hands before eating or drinking. Work clothes should not be worn home. Work clothes should be vacuumed after use and then laundered separately, without shaking, to prevent getting fiber dust into the air.

⚠ WARNING ⚠

Wear safe eye protection at all times while performing brake maintenance to prevent serious personal injury

A periodic schedule for the lubrication, inspection, cleaning and adjustment of brake components should be established depending on specific usage and the wear characteristics encountered by such usage.

NOTE: To compensate for uneven wear, brakes using manual slack adjusters should be adjusted as required to maintain satisfactory operation and maximum safety. Adjustments should provide for uniform lining clearance and proper wear.

LUBRICATION

Lubrication of the camshaft bushings is recommended at 100,000 mile (160,000 km) intervals. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL–MOBILITH AW-1).

Lubricate the camshaft bushings through the fitting provided on the spider or cam bracket. Fill until new grease flows from the inboard and outboard (brake side) seals. Wipe excess grease from the outboard side.

NOTE: Grease the camshaft bracket with a hand-operated gun, to prevent the seals of the camshaft bushings from being forced out of the bore during lubrication.

Brake assembly components such as the anchor pins and rollers should be inspected and lubricated (if needed) every 10,000 miles (16,000 km) and at each brake relining interval or whenever brakes are disassembled. Use lubrication specification S-19 (Multi-Purpose Grease - SHELL–DARINA EP-1).

Anti-seize compound should be applied to the camshaft splines during these intervals. Use lubrication specification S-23 (Anti-Seize - WITCO–CORROSION CONTROL).

NOTE: See Section 10 “Lubrication” for complete information on lube specifications.

DRUM REMOVAL

1. Position main battery switch to “OFF”, and block coach wheels not being serviced.

2. Jack coach and secure with stands before removing wheel.

3. Remove the wheels as outlined in Section 15.

4. Remove machine screws securing drum to hub and remove brake drum.

INSPECTION

Grooves Or Scores

Check around the insides of the drum for deep grooves or scores. If the grooves or scores are not too deep, the drum may be machined and continue to be used. If the grooves or scores are deep, replace the rotor.

Machining Tolerances

Measure the inside diameter of the drum when relining the brakes. The drum I.D. must be at least 14.812 inches (376.2 mm). Replace the drum if the I.D. is less than specified.

Original Diameter	Maximum Allowable
14.50” (368.3 mm)	14.812” (376.2 mm)

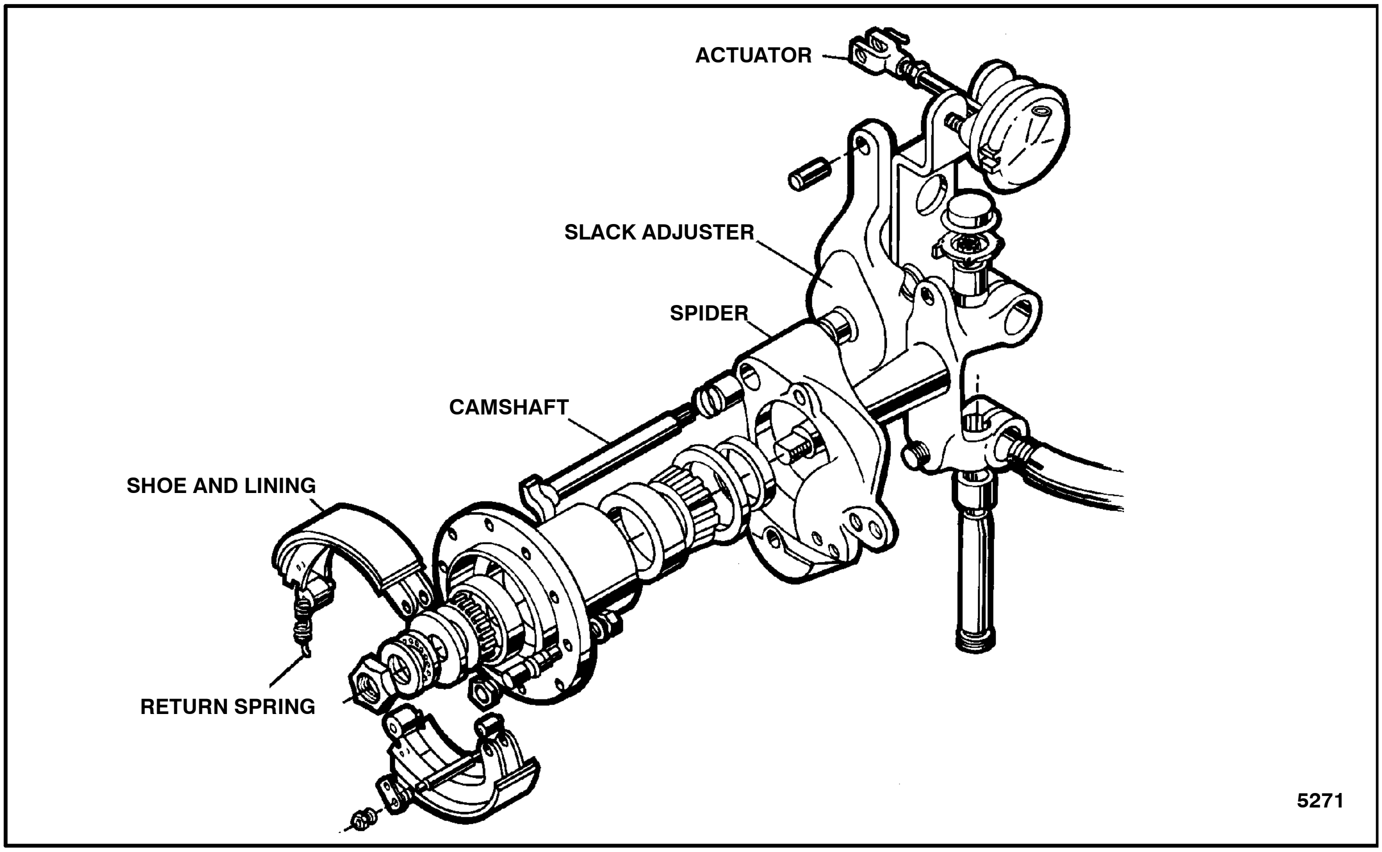


Figure 1. Front Brakes

⚠ WARNING ⚠

Under no circumstances should brake drums be used when machined beyond the maximum allowable dimension.

⚠ CAUTION ⚠

Balanced brake drums are supplied on front axle brake installations. Inspect these drums after machining for proper balance.

When resurfaced drums in combination with oversized linings and/or rollers are used, caution should be exercised regarding the proper operation of the mechanism, and the allowable wear tolerances associated with the use of these components.

DRUM INSTALLATION

1. Install brake drum in reverse order of the removal procedure.

BRAKE SHOE & LINING REMOVAL

⚠ CAUTION ⚠

Linings vary considerably in size and in composition. They should be replaced only with OEM linings listed in the MCI Parts Manual.

1. Position main battery switch to “OFF”, and block coach wheels not being serviced.
2. Jack coach and secure with stands before removing wheel.
3. Remove the wheels as outlined in Section 15.
4. Remove machine screws securing drum to hub and remove brake drum.
5. Place a pry bar between the bottom/top shoe and cam and push shoe away from cam to remove roller.

NOTE: Mark each shoe for correct position at reassembly.

6. Remove the grease fitting from the anchor pin, then remove all fasteners on the anchor pin with the appropriate procedure.

A. On straight pins with a retainer strap, remove capscrew and washer securing strap and remove strap.

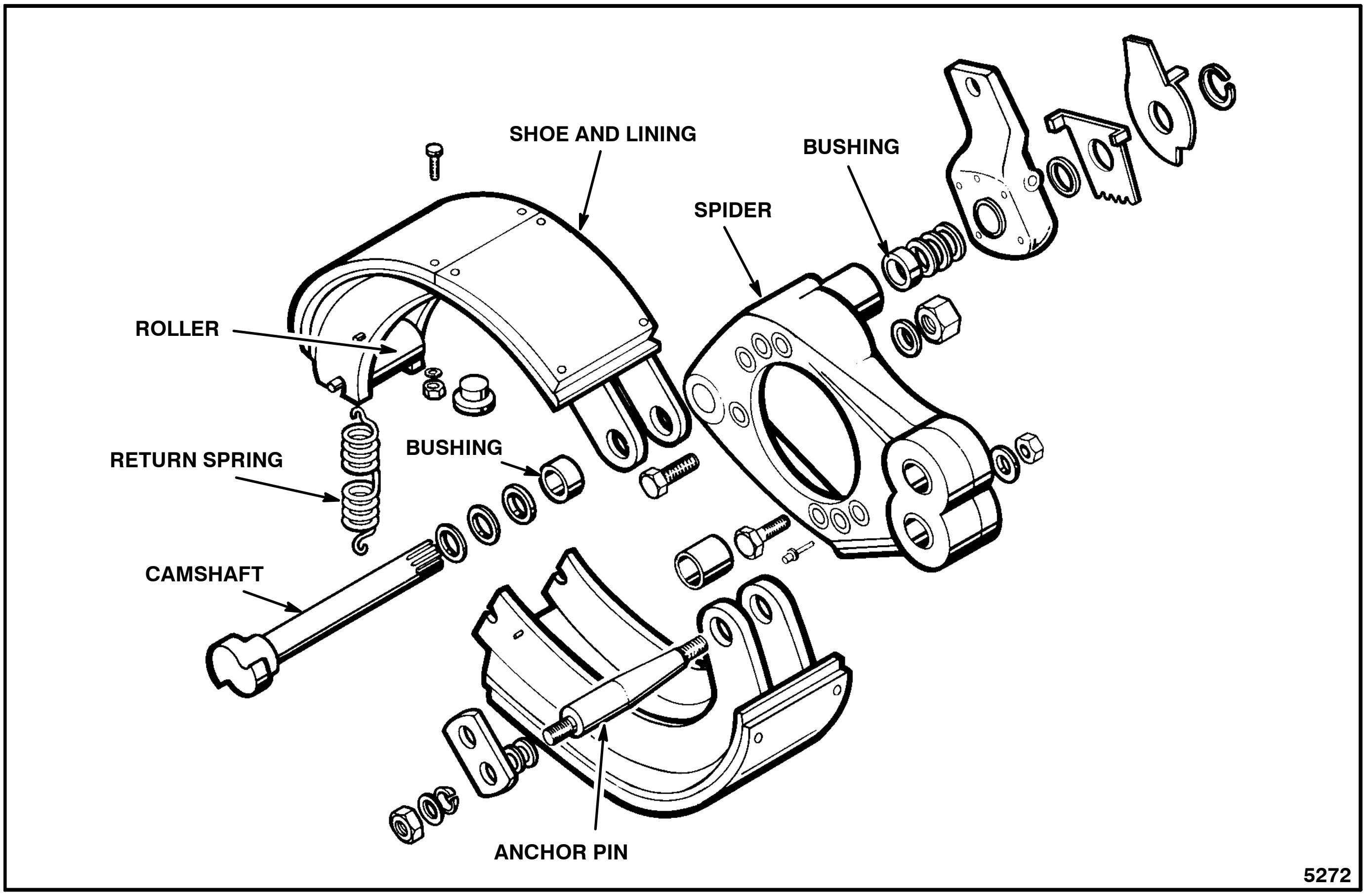


Figure 2. Drive Axle Brakes

B. On straight pins with lock ring and set screw, remove lock ring from top of pin and remove set screw from side of spider.

C. On straight/tapered pins with threads, remove the hex nut and washer securing the anchor pin to spider (slack adjuster side), then remove the hex nut, washer and dowel or lock ring from the shoe side of pin and remove strap.

7. Using a hammer and brass drift, remove the anchor pin from the spider (slack adjuster side).

⚠ WARNING ⚠

Wear proper eye protection, and do not strike the anchor pin, camshafts or other steel parts directly with the hammer.

8. Remove the bushings from either the anchor pin or the shoe.

9. Remove the brake shoe assemblies from the spider, and disconnect the shoe return spring.

10. Remove the brake linings from the shoe assembly.

INSPECTION

NOTE: It's recommended that the following components be replaced at the brake relining interval: Springs, Rollers, Anchor Pins, Clevis Pins and Camshaft Seals.

The following parts should be carefully cleaned and inspected during each brake relining interval. Any components that are worn or damaged should be replaced.

NOTE: Use the "Parts Cleaning & Inspection" procedures at the end of the brake assembly portion.

1. Spider backing plate distortion and/or alignment, and spider attachments.
2. Brake drum fatigue cracks, scoring or other damage.
3. Anchor pin and bushing wear.
4. Camshaft seals and bushing wear.

NOTE: Camshaft maximum lateral end play is .030 inch (.76 mm).

5. Camshaft head, spline and roller wear.
6. Damaged brake shoe welds, anchor pins or expanded anchor pin holes.

BRAKE SHOE & LINING INSTALLATION

1. Install new anchor pin bushings onto the brake shoe if required.

NOTE: Some replacement bushing may require reaming to finish size.

2. Install new brake linings onto the shoes and torque fasteners to 18-23 ft-lbs (24.8-31.6 N·m).

NOTE: Fully lubricate the anchor pins and rollers before installing brake shoes.

3. Install brake shoes in reverse order of the removal procedure.

BRAKE ASSEMBLY REMOVAL

The following removal procedure for Cam-Master W-series drum brakes applies to all axle installations (Figures 1, 2 and 3).

1. Follow steps 1 thru 9 of the previous “Brake Shoe and Lining Removal” procedure.

2. Remove clevis connecting the brake chamber push rod to the slack adjuster arm.

3. Disconnect and remove the slack adjuster from the camshaft by one of the following methods.

A. Remove the capscrew and lockwasher securing slack adjuster on camshaft, remove all spacing washers, and slide slack adjuster off splines.

B. Remove the lock ring securing slack adjuster on camshaft, remove all spacing washers, and slide slack adjuster off splines.

4. Remove any spacer washers remaining on the camshaft after slack adjuster is removed.

5. Pull the camshaft from the spider and/or extension bracket.

6. Remove the thrust washer from behind the camshaft head.

7. If equipped with a camshaft extension bracket, unfasten capscrews and remove from the spider.

⚠ **CAUTION** ⚠

Do not let chamber hang supported only by the air line. Brake chamber mountings may require that chamber hose be disconnected.

8. Mark spider position before removal from mounting flange or knuckle.

9. Unfasten and remove mounting capscrews from spider and mounting flange or knuckle.

NOTE: Spider may be riveted to backing plate at certain locations. Use replacement capscrews at reassembly.

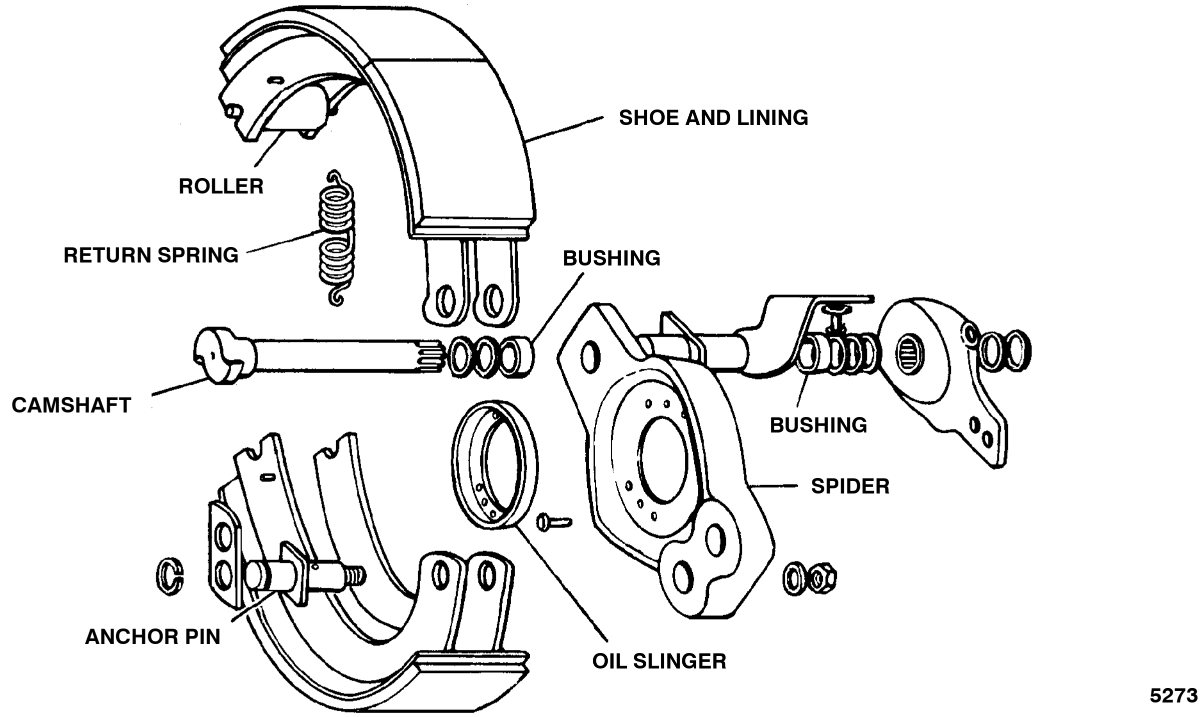


Figure 3. Trailing Axle Brakes

BRAKE ASSEMBLY INSTALLATION

1. Install new camshaft bushings and seals into the spider and extension bracket where required.

NOTE: Some replacement bushing may require reaming to finish size.

2. Install spider mounting capscrews to backing plate or knuckle, and tighten to the following torques.

FRONT (2-Bolt Pattern)	440-580 ft-lbs (596-786 N·m)
FRONT (8-Bolt Pattern)	180-230 ft-lbs (244-312 N·m)
REAR (10-Bolt Pattern	180-230 ft-lbs (244-312 N·m)
TRAILING (8-Bolt Pattern)	85-115 ft-lbs (115-156 N·m)

3. Install brake chamber bracket mounting capscrews to spider when used, and tighten to 85-115 ft-lbs (115-156 N·m) torque.

4. Lubricate the spider and bracket camshaft bushings and seals.

NOTE: Fully lubricate the camshaft bracket after completing assembly procedure.

5. Install the thrust washer on the camshaft, and insert the camshaft into the spider and bracket.

NOTE: Camshaft should turn freely after installation.

6. Reconnect the brake shoe return spring, and position the shoes onto the spider.

7. Install the anchor pins through the shoes by the applicable reverse removal procedure (Step 4A; 4B; 4C and 5).

8. Install the anchor pin bushings through the shoe and onto the pins.

9. To Install camshaft rollers, lift with a pry bar between the shoe and cam. Make sure roller touches both the cam head and the shoe.

10. Reinstall the slack adjuster with all appropriate spacer washers and secure it to the camshaft.

11. New linings should be adjusted to drum diameter. After installation of slack adjuster to camshaft adjust per “Adjustment” procedure shown in Section 4C2.

NOTE: Fully lubricate the slack adjuster after completing assembly procedure.

PARTS CLEANING AND INSPECTION

⚠ WARNING ⚠

If cleaning solvents, alkaline solutions or hot dip tanks are used incorrectly, serious personal injury can occur. To prevent injury, follow the instructions supplied by the manufacturer. Do not use gasoline to clean parts. Gasoline can explode or burn and cause serious injury.

Solvent cleaners can be flammable, poisonous, and can cause burns, Use safe shop practices when using solvents in the cleaning processes, and follow these rules:

- WEAR EYE PROTECTION
- WEAR CLOTHING THAT PROTECTS THE SKIN.
- MAKE SURE THERE IS ENOUGH VENTILATION
- DO NOT USE GASOLINE OR SOLVENTS THAT CONTAIN GASOLINE
- FOLLOW THE MANUFACTURERS INSTRUCTIONS FOR SAFE USE OF THE SOLVENT.

⚠ WARNING ⚠

Do not use gasoline for cleaning parts. Use the proper cleaning solutions and/or solvents to clean brake components. Kerosene or diesel fuel can be used to clean ground or polished parts. All parts must be dried immediately after cleaning.

Ground or Polished Metal Parts

Use a cleaning solvent to clean metal parts and surfaces that are ground or polished. Kerosene or diesel fuel can be used as cleaning solvents.

⚠ CAUTION ⚠

Do not clean ground or polished metal parts in a hot solution tank or with water, steam or alkaline solutions. These solutions will cause corrosion of the parts.

Rough Metal Parts

Clean rough metal parts with cleaning solvents or with a weak alkaline solution in a hot solution tank. If you use a hot solution tank, leave the rough parts in the hot solution until they are completely cleaned and heated. Remove the rough parts from the hot solution tank and wash them with water until the alkaline solution is removed.

Rubber or Plastic Parts

NOTE: Do not use cleaning solvents or alkaline solutions on rubber or plastic parts or they will be damaged.

Dry Parts

Completely dry all parts immediately after cleaning them. Use soft, clean paper or cloth rags, or use compressed air.

NOTE: Do not use compressed air to dry bearings or they will be damaged.

Inspect Parts

It is very important to inspect all parts before reassembling them. Inspect the parts for any signs of wear or damage. Repair or replace any worn or damaged parts. If worn or damaged parts are not replaced, they can cause poor brake performance or a brake failure.

CORROSION PROTECTION

To prevent corrosion, apply a thin layer of brake grease to the parts that have been cleaned, dried and inspected and will be reassembling. Do not apply or allow grease or oil to get on the linings or rotor.

If the parts are to be stored, apply a special material that prevents corrosion and rust to all surfaces. Do NOT apply the material to the brake linings or the rotor. Store the parts inside special paper or other material that prevents corrosion and rust.

BRAKE ASSEMBLY - CAM-MASTER® Q-SERIES

GENERAL DESCRIPTION

The Cam-Master® Q-series brakes are used on optional fifteen inch trailing axle assemblies. These brakes are also air-operated, cam-actuated, internal expanding, dual shoe, heavy-duty drum type brakes. However, these brake assemblies are similar to generic truck brakes, which are larger in diameter than the W-series brakes.

The Q-Plus and Q-Plus "Lite" both incorporate additional retaining springs. These brake assemblies are mounted at the wheel ends of the tag axle, and sized (diameter and width) specifically to the axle brake specification. These brake assemblies also feature all metal construction and open shoe ends that permit quick-change servicing.

Note: Main differences between Q-Plus "Lite" series and standard Q-Plus brake assemblies, are reduced size of spider and brake chamber castings, and that Q-Plus "Lite" assemblies feature a fabricated shoe.

COMPONENTS

The Q-series drum brake assembly contains several major parts. All of these major parts will be discussed, and some other related components such as the brake drums will also be addressed.

LINING

Linings on Q-series 15" x 4" brakes are riveted and are 3/4" thick with tapered ends. The linings are made of high-friction composite type materials for superior coach braking performance. The brake linings are the components most likely to require servicing.

BRAKE SHOE

The two brake shoes are positioned around the inner diameter of the brake drum. The shoes are anchored at one end with straight pins to allow hinge type action, while the other end is fitted with a camshaft roller or follower. The brake shoes are retracted to their normal position by the brake return spring attached to both shoes.

SPIDER

The steel spider assembly holds the brake shoes and components in position at all times, and is the only brake component rigidly attached to the axle. The spider provides mounting holes for brake shoe anchor pins, camshaft actuator and attaching bolts.

Depending on the axle installation, the spider may contain various bushings and grease seals related to integral camshaft mounting. Other installations may require the addition of an extension bracket attached to the rear of the spider to accommodate longer camshafts and/or mounting of the brake chamber.

CAMSHAFT

One camshaft actuator is required per brake assembly, and rotates inside the spider or camshaft bracket. The camshaft design allows connection of the slack adjuster to the splined end, while the cam head end allows both brake shoe rollers to be positioned for actuation. Related serviceable components of the camshaft are the cam bushings and seals.

BRAKE DRUM

The brake drums are designed to allow the brake shoe linings to ride against the inside circumference while being actuated. The drums on the front, trailing and rear axles are of different width, and the front axle drums are balanced. The following chart shows the width of each drum and the location of use.

RETAINING & RETURN SPRINGS

Two retaining springs are used to hold the shoes in place at the anchor pin end. One brake shoe return spring is used to help collapse the shoe after actuation.

TRAILING	15" x 4"

OPERATION

During service brake application, air flows to the brake chamber forcing the push rod to extend. The push rod is attached to the slack adjuster arm, and causes the slack adjuster to rotate, thereby making the camshaft rotate. As the camshaft head turns, the roller or cam follower rides up each cam and moves the brake shoes apart. When the shoes move apart, the linings contact the inner brake drum surface, creating friction and stop the coach.

NOTE: Depending on axle installation camshaft rotation could be clockwise or counter-clockwise.

MAINTENANCE

⚠ WARNING ⚠

The composition of non-asbestos brake linings may contain glass, mineral wool, aramid, ceramic or carbon fibers. Long-term exposure to these types of fibers may cause pneumoconioses, fibrosis and/or cancer. Use caution to avoid the dust from the non-asbestos brake linings when working on them.

The guidelines listed below should be followed to minimize exposure to non-asbestos brake lining dust and particles.

1. Whenever possible, work on brakes in a separate area away from other operations.
2. Always wear a respirator approved by NIOSH or MSHA during all brake service procedures. Wear the respirator from the removal of the wheels through assembly.
3. Never use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends using cylinders that enclose the brake. These cylinders have vacuums with high-efficiency (HEPA) filters with arm sleeves. If such equipment is not available, carefully clean parts and assemblies in the open air.
4. Clean brake parts and assemblies in the open air. During disassembly, carefully place all parts on the floor to avoid getting dust into the air. Use an industrial vacuum cleaner with a HEPA filter system to clean dust from brake drums, backing plates and other brake parts. After using the vacuum, remove any remaining dust with a rag soaked in water and wrung nearly dry.
5. If it is necessary to grind or machine brake linings, additional precautions should be taken because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, such work should be done in an area with exhaust ventilation.
6. When cleaning the work area, never use compressed air or dry sweeping. Use an industrial vacuum cleaner with a HEPA filter and rags soaked in water and wrung nearly dry. Used rags should be disposed of with care to avoid getting dust into the air. Use an approved respirator while emptying vacuum cleaners and handling used rags.
7. After working on the brake system, workers should wash their hands before eating or drinking. Work clothes should not be worn home. Work clothes should be vacuumed after use and then laundered separately, without shaking, to prevent getting fiber dust into the air.

⚠ WARNING ⚠

Wear safe eye protection at all times while performing brake maintenance to prevent serious personal injury

A periodic schedule for the lubrication, inspection, cleaning and adjustment of brake components should be established depending on specific usage and the wear characteristics encountered by such usage.

NOTE: To compensate for uneven wear, brakes using manual slack adjusters should be adjusted as required to maintain satisfactory operation and maximum safety. Adjustments should provide for uniform lining clearance and proper wear.

LUBRICATION

Lubrication of the camshaft bushings is recommended at 100,000 mile (160,000 km) intervals. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL–MOBILITH AW-1).

Lubricate the camshaft bushings through the fitting provided on the spider or cam bracket. Fill until new grease flows from the inboard and outboard (brake side) seals. Wipe excess grease from the outboard side.

NOTE: Grease the camshaft bracket with a hand-operated gun, to prevent the seals of the camshaft bushings from being forced out of the bore during lubrication.

Brake assembly components such as the anchor pins and rollers should be inspected and lubricated (if needed) every 10,000 miles (16,000 km) and at each brake relining interval or whenever brakes are disassembled. Use lubrication specification S-19 (Multi-Purpose Grease - SHELL–DARINA EP-1).

Anti-seize compound should be applied to the camshaft splines during these intervals. Use lubrication specification S-23 (Anti-Seize - WITCO–CORROSION CONTROL).

NOTE: See Section 10 “Lubrication” for complete information on lube specifications.

DRUM REMOVAL

1. Position main battery switch to “OFF”, and block coach wheels not being serviced.
2. Jack coach and secure with stands before removing wheel.
3. Remove the wheels as outlined in Section 15.

4. Remove machine screws securing drum to hub and remove brake drum.

INSPECTION

Grooves Or Scores

Check around the insides of the drum for deep grooves or scores. If the grooves or scores are not too deep, the drum may be machined and continue to be used. If the grooves or scores are deep, replace the rotor.

Machining Tolerances

Measure the inside diameter of the drum when relining the brakes. The drum I.D. must be at least 15.312 inches (388.9 mm). Replace the drum if the I.D. is less than specified.

Original Diameter	Maximum Allowable
15.00” (381.0 mm)	15.312” (388.9 mm)

WARNING

Under no circumstances should brake drums be used when machined beyond the maximum allowable dimension.

When resurfaced drums in combination with oversized linings and/or rollers are used, caution should be exercised regarding the proper operation of the mechanism, and the allowable wear tolerances associated with the use of these components.

DRUM INSTALLATION

1. Install brake drum in reverse order of the removal procedure.

BRAKE SHOE & LINING REMOVAL

CAUTION

Linings vary considerably in size and in composition. They should be replaced only with OEM linings listed in the MCI Parts Manual.

1. Position main battery switch to “OFF”, and block coach wheels not being serviced.
2. Jack coach and secure with stands before removing wheel.
3. Remove the wheels as outlined in Section 15.
4. Remove machine screws securing drum to hub and remove brake drum.

NOTE: Mark each shoe for correct position during assembly.

5. Push down on bottom shoe, and pull roller retaining clip to remove bottom cam roller.
6. Lift on top shoe, and pull roller retaining clip to remove top cam roller.
7. Lift on lower shoe to release the tension on the return spring and remove.
8. Rotate lower shoe to release the tension on the two retaining springs, and remove the springs.
9. Remove the brake shoes from spider assembly.
10. Remove brake lining mounting rivets or fastening hardware, and remove the brake linings from the shoe assembly.

CAUTION

When removing rivets from brake shoes, be careful to avoid damaging holes. Do not use a chisel to shear rivet off as this tends to elongate holes. If holes are burred, they should be filed down flush with the shoe table.

INSPECTION

NOTE: It’s recommended that the following components be replaced at the brake relining interval: Springs, Rollers, Retaining Clips, Clevis Pins and Camshaft Seals.

The following parts should be carefully cleaned and inspected during each brake relining interval. Any components that are worn or damaged should be replaced.

NOTE: Use the “Parts Cleaning & Inspection” procedures at the end of the brake assembly portion.

1. Spider mounting flange distortion and/or alignment, and spider attachments.
2. Brake drum fatigue cracks, scoring or other damage.
3. Camshaft seals and bushing wear.

NOTE: Camshaft maximum lateral end play is .030 inch (.76 mm).

4. Camshaft head, spline and roller wear.
5. Damaged brake shoe welds, brake shoe anchor pins.

NOTE: Brake shoe anchor pins are stacked to the spider assembly on Q-series brakes. Any damage or excessive wear would require new spider assemblies.

BRAKE SHOE & LINING INSTALLATION

1. Install new anchor pin bushings if required.

NOTE: Some replacement bushings may require reaming to finish size.

2. On riveted linings install rivets from center and work outward.

⚠ CAUTION ⚠

Always use a roll set type riveting tool to install rivets. Maximum clearance between shoe and lining after riveting should be .006 inch.

3. On bolted linings install new brake blocks onto the shoes and torque fasteners to 18-23 ft-lbs (24.8-31.6 N·m).

NOTE: Fully lubricate the anchor pins and rollers before installing brake shoes.

4. Install brake shoes in reverse order of the removal procedure.

BRAKE ASSEMBLY REMOVAL

The following removal procedure for Rockwell® Cam-Master Q-series drum brakes applies to optionally equipped trailing axle installations only.

1. Follow steps 1 thru 9 of the previous “Brake Shoe and Lining Removal” procedure.

2. Remove grease fitting, hex nut, washer and strap or plate retainer from the anchor pin.

3. Using a hammer and brass drift, remove the anchor pin from the spider (drive out from slack adjuster side).

⚠ WARNING ⚠

Wear proper eye protection, and do not strike the anchor pin, camshafts or other steel parts directly with the hammer.

4. Remove the anchor pin bushings if required.

5. Remove clevis connecting the brake chamber push rod to the slack adjuster arm.

6. Disconnect and remove the slack adjuster from the camshaft by one of the following methods.

A. Remove the capscrew and lockwasher securing slack adjuster on camshaft, remove all spacing washers, and slide slack adjuster off splines.

B. Remove the lock ring securing slack adjuster on camshaft, remove all spacing washers, and slide slack adjuster off splines.

7. Remove any spacer washers remaining on the camshaft after slack adjuster is removed.

8. Pull the camshaft from the spider and/or extension bracket.

9. Remove the thrust washer from behind the camshaft head.

10. If equipped with a camshaft extension bracket, unfasten capscrews and remove from the spider.

NOTE: Brackets mounting brake chambers may require that chamber air hose be disconnected.

11. Mark spider position before removal from backing plate.

12. Unfasten and remove mounting capscrews from spider and mounting flange or knuckle.

NOTE: Spider may be riveted to backing plate at certain locations. Use replacement capscrews during assembly.

BRAKE ASSEMBLY INSTALLATION

1. Install new camshaft seals into the spider and extension bracket where required.

2. Install new anchor pin bushings into the brake spider where required.

Note: Q-series brake assemblies have serviceable anchor pin bushings. Some replacement bushings may require reaming to finish size.

3. Install spider mounting capscrews to mounting flange or knuckle, and torque to 175-190 ft-lbs (237-257 N·m).

4. Install brake chamber bracket mounting capscrews to spider when used, and tighten to 85-115 ft-lbs (115-156 N·m) torque.

5. Lubricate the spider and brake chamber extension bracket camshaft bushings and seals.

NOTE: Fully lubricate the camshaft bracket after completing assembly procedure.

6. Install the thrust washer on the camshaft, and insert the camshaft into the spider and bracket.

NOTE: Camshaft should turn freely after installation.

7. Install the anchor pins, strap or plate, washers and hex nuts onto the spider, and torque to 325-375 ft-lbs (440-508 N·m).

8. Reconnect the brake shoes using the “Brake Shoe & Lining Installation” procedure.

9. Install camshaft rollers by lifting with a pry bar between the shoe and cam. Make sure roller touches both the cam head and the shoe.

10. Reinstall the slack adjuster with all appropriate spacer washers and secure it to the camshaft.

11. New linings should be adjusted to drum diameter. After installation of slack adjuster to camshaft adjust per “Adjustment” procedures later in this section.

NOTE: Fully lubricate the slack adjuster after completing assembly procedure.

PARTS CLEANING AND INSPECTION

WARNING

If cleaning solvents, alkaline solutions or hot dip tanks are used incorrectly, serious personal injury can occur. To prevent injury, follow the instructions supplied by the manufacturer. Do not use gasoline to clean parts. Gasoline can explode or burn and cause serious injury.

Solvent cleaners can be flammable, poisonous, and can cause burns, Use safe shop practices when using solvents in the cleaning processes, and follow these rules:

- WEAR EYE PROTECTION
- WEAR CLOTHING THAT PROTECTS THE SKIN.
- MAKE SURE THERE IS ENOUGH VENTILATION
- DO NOT USE GASOLINE OR SOLVENTS THAT CONTAIN GASOLINE
- FOLLOW THE MANUFACTURERS INSTRUCTIONS FOR SAFE USE OF THE SOLVENT.

WARNING

Do not use gasoline for cleaning parts. Use the proper cleaning solutions and/or solvents to clean brake components. Kerosene or diesel fuel can be used to clean ground or polished parts. All parts must be dried immediately after cleaning.

Ground or Polished Metal Parts

Use a cleaning solvent to clean metal parts and surfaces that are ground or polished. Kerosene or diesel fuel can be used as cleaning solvents.

CAUTION

Do not clean ground or polished metal parts in a hot solution tank or with water, steam or alkaline solutions. These solutions will cause corrosion of the parts.

Rough Metal Parts

Clean rough metal parts with cleaning solvents or with a weak alkaline solution in a hot solution tank. If you use a hot solution tank, leave the rough parts in the hot solution until they are completely cleaned and heated. Remove the rough parts from the hot solution tank and wash them with water until the alkaline solution is removed.

Rubber or Plastic Parts

NOTE: Do not use cleaning solvents or alkaline solutions on rubber or plastic parts or they will be damaged.

Dry Parts

Completely dry all parts immediately after cleaning them. Use soft, clean paper or cloth rags, or use compressed air.

NOTE: Do not use compressed air to dry bearings or they will be damaged.

Inspect Parts

It is very important to inspect all parts before reassembling them. Inspect the parts for any signs of wear or damage. Repair or replace any worn or damaged parts. If worn or damaged parts are not replaced, they can cause poor brake performance or a brake failure.

CORROSION PROTECTION

To prevent corrosion, apply a thin layer of brake grease to the parts that have been cleaned, dried and inspected and will be reassembling. Do not apply or allow grease or oil to get on the linings or rotor.

If the parts are to be stored, apply a special material that prevents corrosion and rust to all surfaces. Do NOT apply the material to the brake linings or the rotor. Store the parts inside special paper or other material that prevents corrosion and rust.

BRAKE CHAMBERS

GENERAL DESCRIPTION

The service brake system utilizes chamber actuated brake assemblies on all axles. The diaphragm type brake chambers convert the energy of compressed air into a mechanical force. The brake chambers are integral components in the operation of the service and emergency/parking brake systems of this coach.

Two basic types of brake chambers are used in the air brake system installations. Single diaphragmed brake chambers are used on front and trailing axle brakes, while double diaphragmed brake chambers are used exclusively on the drive axle brake assemblies.

NOTE: Coaches built prior to October 1994 do not have stroke indicators on their brake chambers. All coaches produced after this date are fitted with brake chambers featuring a stroke indicator for quickly determining an over-extended condition (i.e., brakes out of adjustment).

DD3 brake chambers do not have the push rod stroke indicator, because the splash boot covers push rod at that location. The “Out of Service Criteria” for this brake chamber is a stroke of less than 2-1/4”. Normal stroke is 2-7/8”

Several different size brake chambers are used on the D series coaches. All Rockwell front axles with drum brake installations are fitted with Type 24 brake chambers. All Rockwell rear drive axles are fitted with Type 30 DD3 brake chambers. The trailing axle of the 102D3 uses Type 12 chambers with W-series drum brake installations and Type 16 on the Q-series drum brake installations.

NOTE: The 102DL3 trailing axle is fitted with disc brake installations only. See Section 4C2 for the brake chambers used for this axle.

All brake chambers feature anti-corrosion construction and a mechanically sealed (clamped) body for easy service. All brake chambers will require periodic inspection and maintenance.

COMPONENTS

Generally, most single and dual-diaphragm push rod type brake chamber designs will consist of the same basic internal parts.

PUSH ROD

The push rod connects to and relays the force of the brake chamber to the slack adjuster. Later model brake chambers will incorporate an over-extension stroke alert indicator band on the push rods.

NOTE: The clevis assemblies used for attaching the slack adjuster to the brake chamber push rod are model specific. The Haldex® slack adjusters are connected with a single pin, threaded type yoke clevis and jam nut. The Rockwell slack adjusters require a “Quick-Connect” type, double pin yoke clevis and snap-ring collar (threaded) with jam nut to connect push rod.

DIAPHRAGMS

The diaphragm separates the pressure and non-pressure retaining areas of the brake chamber. Diaphragms are made of reinforced rubber or other similar materials. The diaphragm is held in place by the clamping ring.

RETURN SPRING

The brake chambers typically incorporate some type of return spring mechanism. The return spring assures that the push rod will return to the unextended position after each brake application.

CLAMP RING

Bolted brake chamber clamping rings hold the different sections (service/park) of the chamber body together.

BODY

The brake chambers installed on the front, rear and trailing axles are of different size and capacity. Body diameters and/or sectional make-up of each chamber will appear different from one axle to another. The following chart will help in identifying the specific brake chamber used. Dimension are O.D. clamping ring.

FRONT DRUM (Bendix)	**Type-24 (7-7/32” O.D.)**
REAR DRUM (Bendix)	**Type-30 DD3 (8-3/32” O.D.)**
TAG DRUM 102D3 W (Bendix)	**Type-12 (5-11/16” O.D.)**
TAG DRUM 102D3 W(M/Grau)	**Type-12 (5-3/4” O.D.)**
TAG DRUM 102D3 Q (Bendix)	**Type-16 (6-1/2” O.D.)**

NOTE: Bendix Type 12 brake chambers with stroke indicators will not be offered. The alternate Type 12 with stroke indicator are P/N’s 4L-5-17 (RH) and 4L-5-18 (LH).

OPERATION

SINGLE DIAPHRAGM CHAMBERS

Single diaphragm brake chambers have pressure and non-pressure retaining areas. Air pressure enters the pressure retaining side of the brake chamber diaphragm, which balloons the diaphragm and moves the push rod assembly forward. When air pressure is released from the brake chamber the push rod return spring, in combination with other brake component mechanisms, returns the push rod and diaphragm to their normal position.

DOUBLE DIAPHRAGM CHAMBERS

The Bendix-Westinghouse DD3 model dual brake chamber utilizes an air applied parking brake. This type of brake chamber requires pressurized air to release a separate push rod locking mechanism.

During a normal service brake application the service (primary) portion of the brake chamber works like a single diaphragm brake chamber. Air in the non-pressurized area is exhausted through an open port.

During normal park brake application the park side of the chamber is designed to fill with air and apply when the brake control knob is pulled out, however, in an emergency application (when service air system pressure falls below approximately 45 psi), the park side would be applied automatically through a separate emergency park brake control arrangement and air circuit.

During normal service brake applications the lock mechanism remains pressurized to allow free push rod travel. However, during both normal and emergency park brake applications the locking mechanism is exhausted, allowing the push rod to be locked in place if the rod attempts to retract. A partial service brake application is required to release lock mechanism.

The normally applied park brake may be released after the park valve knob is pushed in. When the valve is so positioned air in the park portion of the chamber is exhausted, and the lock mechanism is again pressurized.

CAUTION

Avoid applying the parking brakes until the coach has come to a complete stop, and service brakes have been released. The increased pressures from a combination of service and park brake applications could cause over-extension of push rod and jam rear brake assemblies.

CAUTION

Brake chamber push rod travel should be kept as short as possible without causing brake drag. Excessive push rod travel shortens diaphragm life, gives slow braking response and wastes air. The push rod should extend and retract properly without binding.

NOTE: All pressurized brake chamber air is exhausted through brake system control valves.

INSPECTION

OPERATIONAL & LEAKAGE TESTING

An operational check for brake chamber push rod travel and/or leakage should be performed every 8,000 miles (12,720 km) or 300 service hours per the periodic maintenance schedule below. The inspections can be easily performed by following these simple procedures.

1. Check push rod-to-slack adjuster alignment in both the applied and released positions.
2. Check that push rod travel is as short as possible without causing any brake drag.
3. Check that the proper air system pressure is available in both reservoirs for testing brakes (90-to-100 psi).

NOTE: The air brake chamber push rod stroke can be difficult to measure properly. To determine proper brake chamber and/or slack adjuster performance, push rod stroke must be accurately measured at a 90-to-100 psi service brake application as recommended by the Commercial Vehicle Safety Alliance (CVSA). The stated pressure range is measured at reservoir, with engine off. All excess pressure is to be dumped before the brakes are fully applied.

CAUTION

Inspect for worn camshaft bushings. Camshaft bushing wear contributes to longer push rod stroke and shorter chamber service life.

The optimum slack adjuster arm and push rod intersecting angular connection should show an obtuse (more than 90 degree) angle present at the arm-to-rod connection when at rest, while a 90 degree or a slightly acute (less than 90 degree) angle might be present during rod extension (Figure 4).

4. Check that push rod extension and retraction dimensions are within specification, and note that rod moves out and returns properly and without binding.

NOTE: New brake chambers will incorporate an over-extension stroke alert indicator band on the push rods. If band is observed during operational inspection, an over-extension condition exists and must be corrected. Refer to the at-rest and extended dimensions for brake chambers with or without the over-extension indicators (Figure 4).

5. With system pressure at normal operating levels, make and hold a full service brake application. Perform a soap bubble test on all clamp rings and push rod seals. Repeat this procedure with parking brake applied. No leakage is permitted under these conditions.

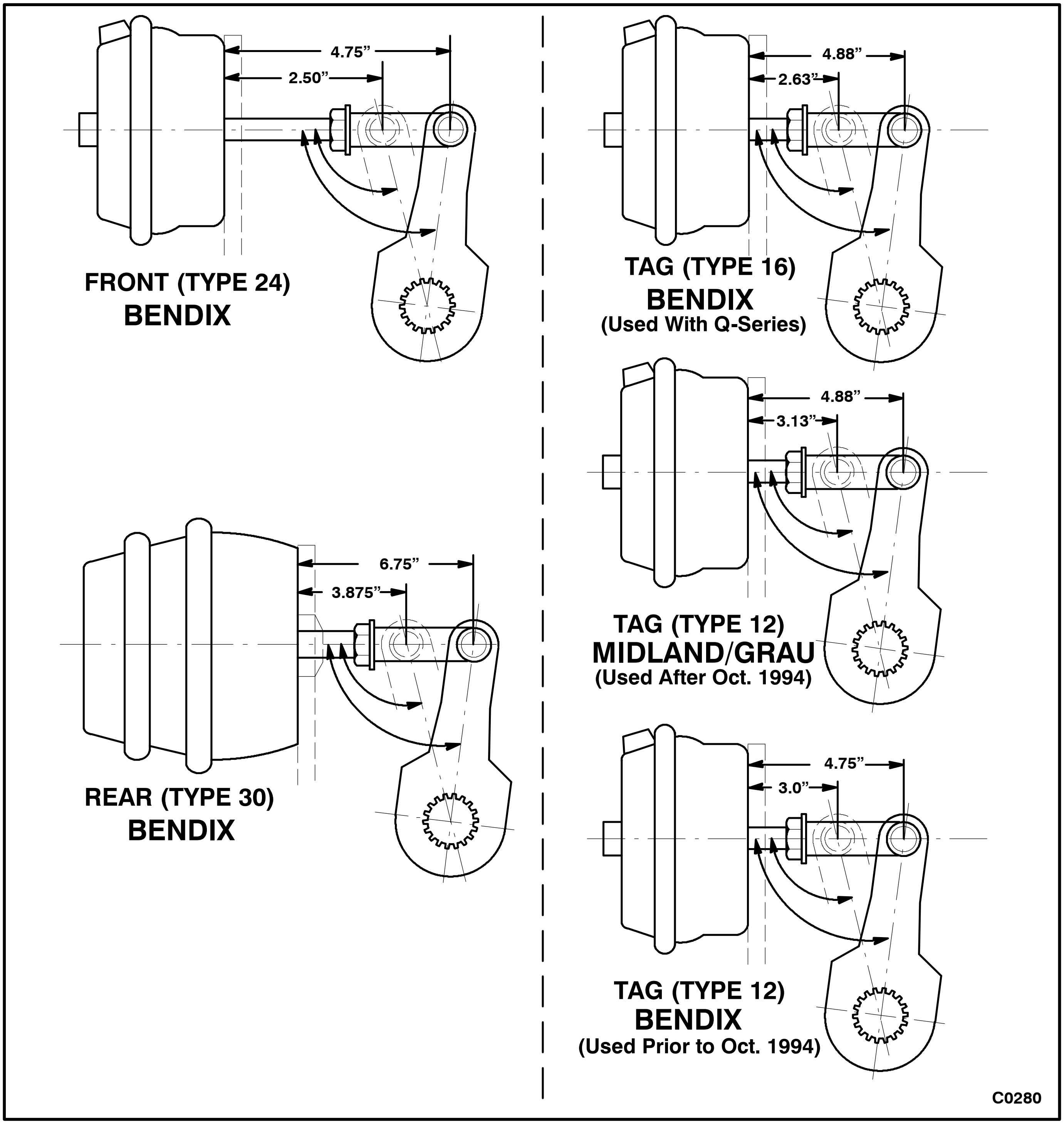

4.75"
2.50"
FRONT (TYPE 24)
BENDIX
4.88"
2.63"
TAG (TYPE 16)
BENDIX
(Used With Q-Series)
4.88"
3.13"
TAG (TYPE 12)
MIDLAND/GRAU
(Used After Oct. 1994)
6.75"
3.875"
REAR (TYPE 30)
BENDIX
4.75"
3.0"
TAG (TYPE 12)
BENDIX
(Used Prior to Oct. 1994)
C0280

Figure 4. Push Rod Adjustments

6. Check brake chamber mounting torques, clamp ring fastener torques, hose routing clamps and hose connections.

CAUTION

Clamp ring capscrews should be tightened evenly. Flange leakage could indicate uneven torques. Over torquing of fasteners could cause diaphragm flange sealing surface or clamping ring distortion.

MAINTENANCE

LUBRICATION

Lubricate the Bendix-Westinghouse Type 30 DD3 brake chamber locking mechanism every 25,000 miles (40,000 km) or 900 service hours. Use lube specification S-18 (AREO “Lubriplate”) as shown in Section 10.

REMOVAL

1. Block coach by means other than the park brakes.

2. Exhaust all coach service and park brake system air.

WARNING

Exhaust all air from coach brake systems including the emergency/park air systems before removing any brake chamber hoses. Pressurized hoses could whip and cause personal injury.

NOTE: On rear axle Bendix chamber, after disconnecting the parking and service port lines, operate the parking control valve. This action should exhaust the isolated air supply and air from the locking port.

3. Disconnect the air lines from top (front/tag) or side (rear) of the brake chamber.

4. Unfasten and remove push rod yoke from the slack adjuster, and push the rod all the way in (front/tag chambers only).

5. Unfasten and remove brake chamber from mounting bracket.

NOTE: Clean exterior and match mark all chamber components before disassembly.

DISASSEMBLY

Every 100,000 miles (161,000 km) or every 3000 service hours (more often for severe service), disassemble the brake chambers. Clean and inspect all parts.

NOTE: Some chambers may be dismantled while still attached to vehicle (i.e., minor diaphragm or spring replacement). Shop air may be required to unlock or extend push rod.

Single Diaphragm Chambers

1. Pull push rod out and clamp with vise or vise grip pliers to relieve internal return spring tension on the pressure plate.

CAUTION

Jaws of vise or vise grip pliers should be covered or taped to prevent damage to the push rod.

2. Unfasten and remove clamp ring segments (Figure 5).

NOTE: Some chambers use full round clamping rings. Spread clamp ring slightly to slip it off the flange. Do not bend or scar clamp ring retaining lips while removing.

3. Remove the pressure plate and diaphragm.

4. Release vise or vise grip clamp on push rod and slowly allow spring to expand.

5. Remove clevis yoke and locknut from push rod, and remove push rod from chamber.

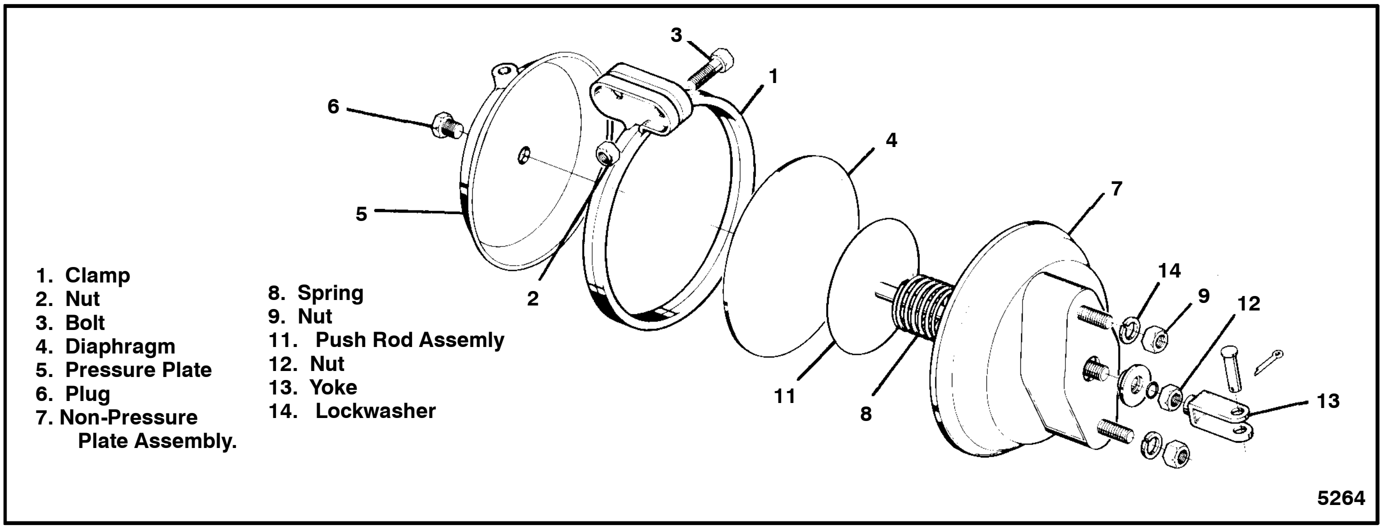
6. Clean metal parts with solvent, and inspect all metal and rubber components for cracks, distortion or other damage.

NOTE: Diaphragm and return spring replacement should be done in sets. Both the right and left hand chambers of a given axle should be changed in order to maintain even brake application forces. Install new diaphragms or seals when worn or deteriorated.

Double Diaphragm Chamber

1. Remove yoke, yoke locknut, boot, splash guard and breather if installed.

2. Follow steps 1 and 2 of previous procedure.



1. Clamp
2. Nut
3. Bolt
4. Diaphragm
5. Pressure Plate
6. Plug
7. Non-Pressure Plate Assembly.
8. Spring
9. Nut
11. Push Rod Assemly
12. Nut
13. Yoke
14. Lockwasher

Figure 5. Front and Trailing Axle Brake Chambers

> **NOTE:** Remove auxiliary side (rear) clamping ring first. It may be necessary to use a soft mallet to break the clamping rings loose. If the rings are being reused, care should be taken against bending them out of shape.

3. After clamping rings are removed, the auxiliary pressure plate, auxiliary diaphragm service pressure plate and service diaphragm may be removed.

4. Place the remains of actuator on a smooth surface with the push plate down. Connect an air supply (shop air) line to the locking port.

5. By hand, press down the actuator non-pressure plate and at the same time apply air to the locking port. As the shaft is unlocked, ease the non-pressure plate back and remove the push plate and shaft assembly with push rod and return spring (Figure 6).

6. Hold the lock cap down against roller spring tension and completely remove all four capscrews before releasing and removing the cap.

7. Remove roller spring and spring seat washer. Remove all eight rollers.

8. Next cautiously apply air at the locking port to assist in removal of collar and piston, and to remove piston O-ring.

9. Inspect the bearing in shaft bore and remove it only if it is showing signs of wear.

> **NOTE:** The push rod should not be removed from the shaft unless it is damaged. If the rod is removed it must be replaced.

10. To remove the rod, place a heavy washer over the rod against the shaft, then position a spacer and a second washer over the rod and beneath the yoke locknut. Turn the locknut down with a long handled wrench, pulling the push rod from the shaft.

11. The knurled T-bolts in the non-pressure plate can be removed and replaced if damaged.

Inspection

1. Wash all metal parts in a cleaning solvent and dry. Any reusable parts should be wiped clean. Discard breather.

2. Inspect all parts for excessive wear or deterioration. Particular attention should be given to the piston and collar cores in the plate.

3. The air passage from the lock port to piston bore should be clean and not restricted. It may be necessary to remove the inspection plug to thoroughly clean this passage.

4. Rollers should all be replaced if one or more need replacing. Check the springs for cracks, distortion or corrosion. Replace all parts not serviceable.

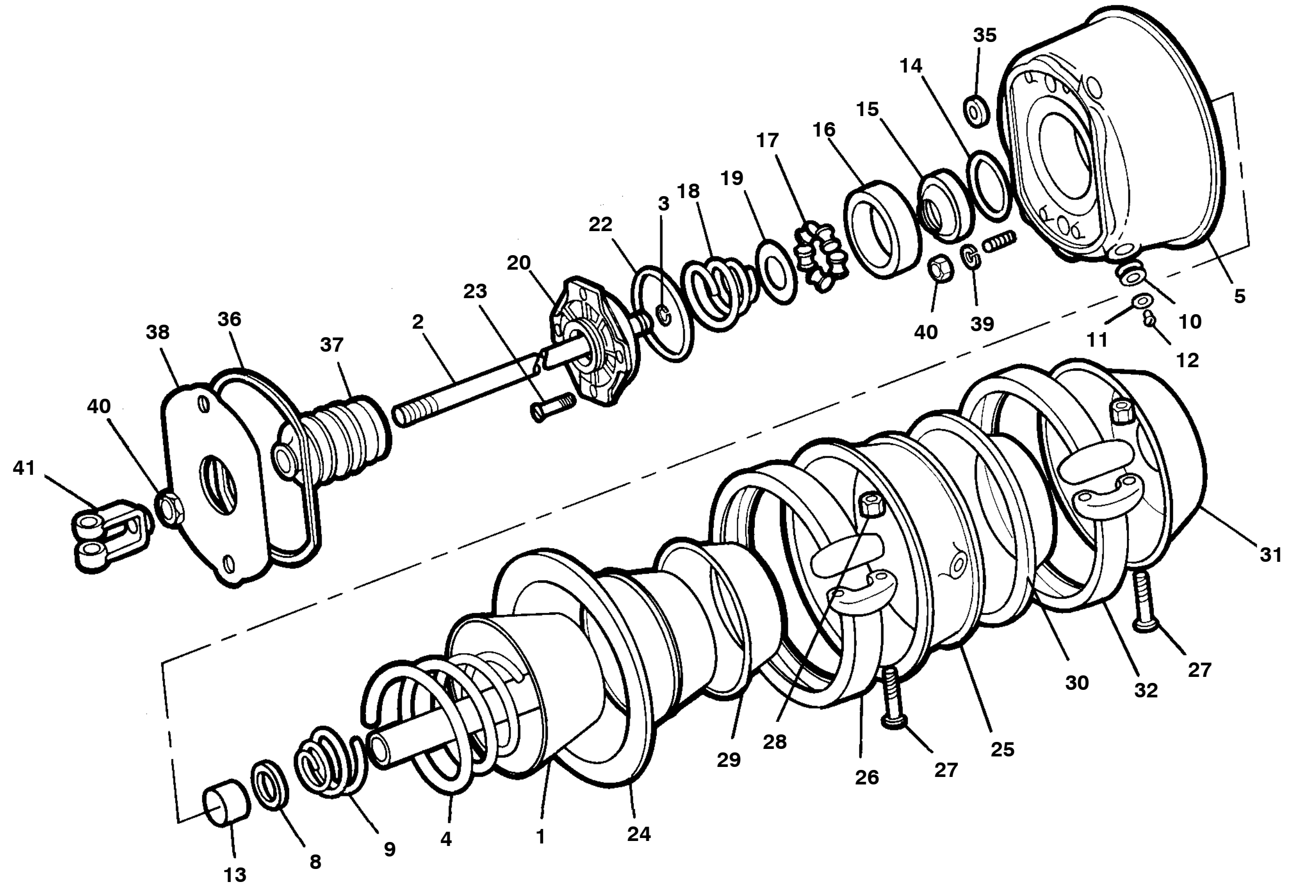
> **NOTE:** Use lube specification S-26 (55 O-RING LUBE Dow Corning) or specification S-24 (316 SPRAY Dow Corning) also shown in Section 10**.**

ASSEMBLY

Single Diaphragm Chambers

1. Install new parts and assembling in the reverse order of the disassembly procedure.

2. Apply shop air and test for air leakage before installing on coach.



No.	Part
1 .	Shaft Assembly.
2.	Push Rod
3.	Retaining Ring
4.	Return Spring
5.	Non-Pressure Plate Assembly
8.	Wiper
9.	Retaining Spring
10.	Diaphragm
11.	Washer
12.	Screw
13.	Bearing
14.	O–Ring
15.	Piston
16.	Collar
17.	Roller
18.	Spring
19.	Washer
20.	Cap
22.	O–Ring
23.	Screw
24.	Service Diaphragm
25.	Service Pressure Plate
26.	Service Clamp Ring
28.	Bolt
28.	Nut
29.	Diaphragm Separator
30.	Auxiliary Diaphragm
31.	Auxiliary Pressure Plate
32.	Auxiliary Clamp Ring
35.	Felt Breather
36.	Gasket
37.	Boot
38.	Splash Guard
39.	Lockwasher
40.	Nut
41.	Yoke Assembly.

Figure 6. Rear Axle Brake Chamber

Double Diaphragm Chamber

1. Line up parts as they were marked prior to disassembly.

2. Lubricate the piston and collar bores, shaft, piston O-ring and piston cavity with silicone base lubricant.

3. Position the O-ring in the piston with smooth end down. Place the collar in its bore in the plate.

4. Position all eight rollers in the groove formed by the top of the piston and collar rollers.

5. Position the cone shaped roller spring on the washer with the small end to washer.

6. Position the cap on the roller spring. Press the cap and hold while installing capscrews evenly.

7. Turn the non-pressure plate lock mechanism installed and position the return spring in the plate with the large end down.

8. Position the push plate and shaft over the spring and press down so the shaft moves through the lock. The lock should hold the shaft position against return spring. If not, check assembly at this point.

9. Install the service diaphragm, service pressure plate and clamping ring.

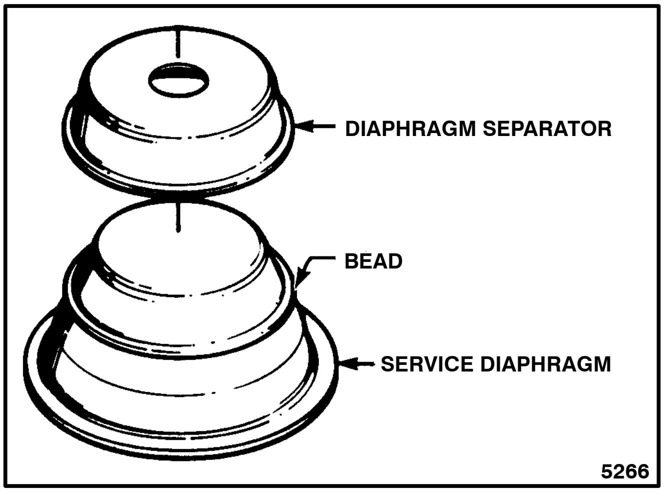


Figure 7. Diaphragm W/Separator Bead

NOTE: A diaphragm separator may be molded into the service diaphragm, check the old diaphragm for the presence of a molded bead (Figure 7). A separator type service diaphragm is required as replacement, and may be included in some repair kits as a third or separate piece.

10. Install the auxiliary diaphragm, auxiliary pressure plate and clamping ring.

11. Evenly tighten the clamping ring bolts in both clamping rings evenly.

12. Install the new breather, and splash guard over boot.

INSTALLATION

1. Mount brake chamber onto the brake chamber mounting bracket and torque nuts to 30-50 ft-lbs (40.7-67.8 N·m).

2. Install clevis yoke and locknut on push rod and connect to slack adjuster arm with the clevis pin.

NOTE: Install actuators with the drain slot pointing down.

3. Connect the air lines to the chamber taking care that the correct line is installed.

SLACK ADJUSTERS - MANUAL

GENERAL DESCRIPTION

The basic service brake assemblies of the D series coaches are equipped with Bendix® positive lock manual slack adjusters. The manual slack adjusters provide for quick adjustment of drum brake linings. This manual adjustment, when properly performed during each slack adjusters lubrication interval, should compensate for a normal brake lining wear.

NOTE: All coaches produced after October 1994 will be equipped with automatic slack adjusted service brake installations.

Unlike automatic slack adjusters, the manual slack adjusters are mounted in similar fashion on each axle (Figure 8).

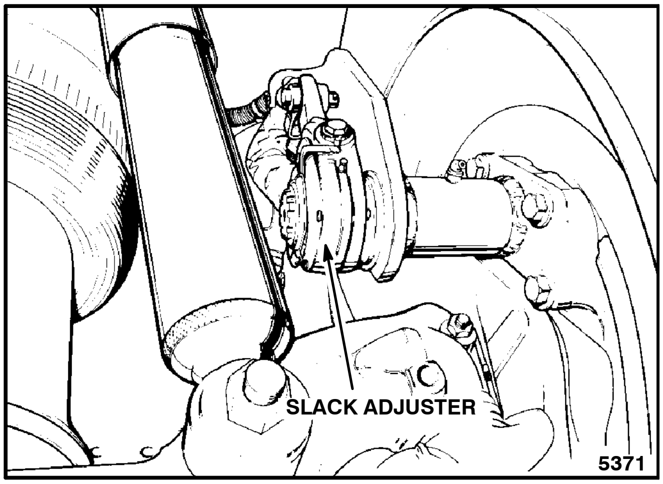


Figure 8. Manual Slack Adjuster Installed

COMPONENTS

SLACK ADJUSTER

The slack adjusters have various push rod attaching arm configurations (i.e., straight, offset) for the different axle installations. These slack adjusters utilize a worm gear drive to ensure maximum service with minimal maintenance. The manual slack adjuster installations do not have control arms or anchor bracket mountings, but do incorporate an adjusting capscrew and a locking collar to maintain adjustments.

NOTE: The manual slack adjusters have no serviceable components.

OPERATION

When the service brakes are applied, the brake chamber push rod moves outward. The slack adjuster rotates, turning the camshaft and moves the shoes into contact with the drum. After continued operations, the linings wear down and must be manually readjusted. The Bendix® manual slack adjusters utilize a completely sealed actuator mechanism to ensure maximum service life and minimal maintenance.

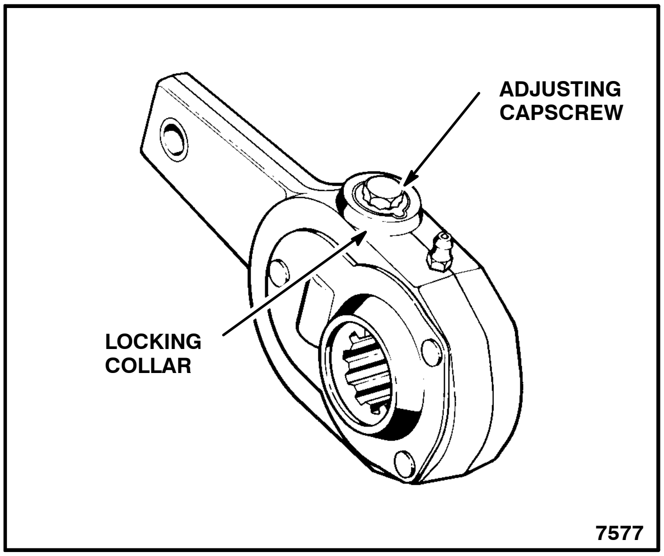


Figure 9. Typical Slack Adjusters

MAINTENANCE

OPERATIONAL CHECK

The slack adjusters should have an operational check performed during each lubrication interval.

1. Apply the coach brakes and inspect to ensure that the slack adjusters rotate freely and without binding. Inspect that over-stroke indicators are not visible.
2. Release the brakes and check to be sure that slack adjusters return to a released position freely without binding.

LUBRICATION

Slack adjusters must be lubricated every 5,000 miles (8,000 km) or 150 hours. Use lubrication specification S-16 or S-19 (Multi-Purpose Grease MOBILITH AW-1 or DARINA EP-1) as shown in Section 10.

ADJUSTMENT

These procedures may be used for either adjusting brakes after replacing linings or for an operational check during lube intervals.

NOTE: Ensure that the park brake and locking mechanism (Bendix) is released prior to adjusting the rear brakes. Wheel must be jacked and able to turn while adjusting brakes.

1. Position main battery switch to “OFF”, and block all other coach wheels.
2. Wipe clean the adjuster capscrew and collar before adjusting brakes.
3. Push down on locking collar and install a socket with 1/2” drive ratchet onto the adjusting capscrew of the slack adjuster (Figure 9).
4. Gently rotate wheel and turn the adjusting capscrew clockwise until the lining contacts the brake drum.

⚠ CAUTION ⚠

Do not turn adjusting capscrew until the locking collar is depressed.

NOTE: Adjust linings until brakes stop the turning wheel. Do not use excessive force to turn adjusting capscrew.

5. Back off the adjusting capscrew by turning counter-clockwise one-quarter to one-half turn (3-to-6 notches of the locking collar).

⚠ CAUTION ⚠

Do not use an impact wrench to turn adjusting capscrew as damage will occur to the adjuster mechanism.

6. When adjustments have been completed, ensure that the locking sleeve is returned to a locked position by permitting it to engage the head of the adjusting capscrew.
7. After adjustments are complete, make a full service brake application (90 to 100 psi.) and check push rod stroke, then release brakes to check lining-to-drum-clearance for proper operation.

NOTE: The air brake chamber push rod stroke can be difficult to measure properly. To determine proper slack adjuster performance, push rod stroke must be accurately measured at a 90 to 100 psi service brake application as recommended by the Commercial Vehicle Safety Alliance (CVSA).

REMOVAL

1. Position main battery switch to “OFF”, block coach wheels, release parking brake.
2. Install a socket with 1/2” drive ratchet onto the adjusting capscrew, and rotate one full turn counter-clockwise to release brakes.
3. Remove the brake chamber push rod clevis pin from slack adjuster arm and remove push rod.
4. Unfasten and remove slack adjuster to brake camshaft retaining hardware (i.e., capscrew or snap ring).
5. Slide the slack adjuster and spacer washers off the spine end of the camshaft.

NOTE: Mark all spacer washers for reinstalling in their proper positions.

INSTALLATION

NOTE: When installing a slack adjuster, clearance must be allowed to ensure that the slack adjuster can be rotated to the maximum stroke of the brake chamber.

1. With main battery switch still “OFF” and wheels blocked, make sure that all brake chamber push rods are fully retracted.
2. Apply anti-seize compound to the camshaft splines.
3. Reinstall all spacer washers on camshaft, then slide slack adjuster onto the end of the camshaft. and secure it with appropriate fasteners.

NOTE: It is recommended that the positive lock slack adjusters be installed in a compression mounting direction (adjuster and grease fitting pointing away from brake chamber).

4. Install all other spacer washers, and secure slack adjuster with appropriate fasteners.
5. Refer to Operating Test to ensure that proper adjustments are made to provide for these conditions when installing the slack adjuster.

SLACK ADJUSTERS - AUTOMATIC

GENERAL DESCRIPTION

The service brake assemblies of some coaches may be equipped with either Haldex® or Rockwell® automatic slack adjusters. These slack adjusters provide for automatic adjusting of the drum brakes through each service application. This constant adjusting during each brake application compensates for normal brake lining wear.

> **NOTE:** All coaches produced after October 1994 will be equipped with automatic slack adjusted service brake installations.

There are several different styles of slack adjuster mountings, due to the various slack adjuster installations that exist for each manufacturer. All applicable mountings and their specific procedures will be discussed in this section.

> **NOTE:** Only Haldex® automatic slack adjusters are installed on front axle brake installations. Some trailing axle installations equipped with W-series brake assemblies are also fitted only with Haldex® brand slack adjusters.

COMPONENTS

SLACK ADJUSTER

The slack adjuster casting may be configured with either a straight or offset push rod attachment arm depending on the axle installation. Some slack adjusters may feature a pointer style indicator to identify correct installation and/or adjustment (i.e., Haldex® front axles). Both slack adjusters incorporate an adjusting hex screw, however, the Haldex® is also fitted with an auto-adjust control bracket.

> **NOTE:** The internal mechanisms of the automatic slack adjusters are not user serviceable.

ANCHOR BRACKET

The Haldex® automatic slack adjusters require a control arm anchor bracket. The style of anchor bracket mounting varies depending on coach model and axle installation. The anchor screw attaches the anchor bracket to the control arm of the slack adjuster. Descriptions of the various anchor bracket mounting methods follow.

Clamp Style

This type slack adjuster anchor bracket is fastened to the camshaft extension housing (Figure 10). Axle installations using the strap type clamping method (i.e., rear and trailing) will appear similar to this.

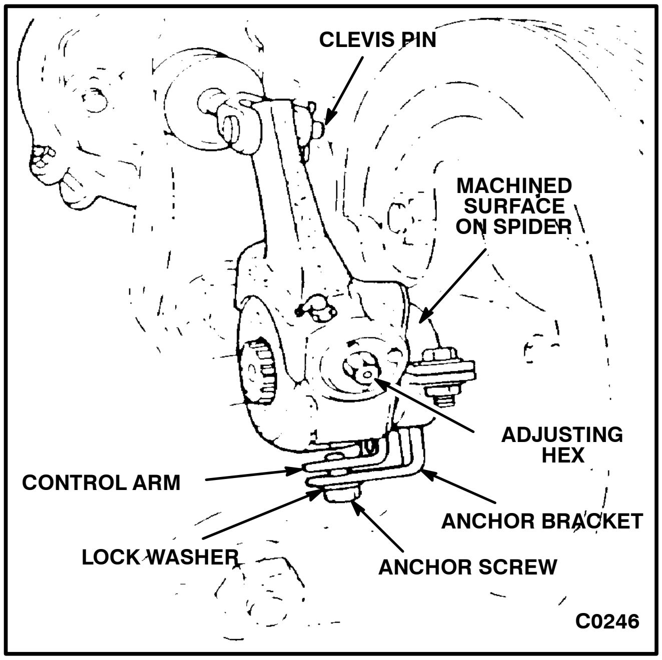


Figure 10. Clamp Style Anchor

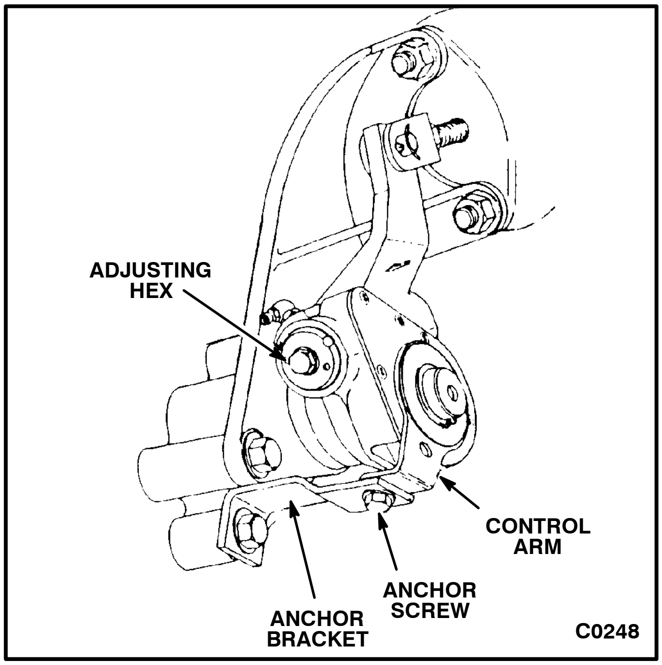


Figure 11. Angle Style Anchor

Angle Style

This style slack adjuster anchor bracket is fastened by the camshaft extension housing capscrew (Figure 11).

CLEVIS

The clevis assemblies for attaching the slack adjuster to the brake chamber push rod are model specific. The Haldex® slack adjusters are connected with a single pin, threaded, standard type yoke clevis with jam nut. The Rockwell® slack adjusters require a non-threaded, double pin clevis design connected with an internal snap ring threaded collar and jamnut to attach the slack adjuster to the push rod.

OPERATION

HALDEX® SLACK ADJUSTER

When the service brakes are applied, the brake slack adjuster rotates and moves the shoes into contact with the drum. The clearance notch (Key "A") corresponds to the normal lining-to-drum clearance. As the brake application continues, the rack (Key "B") moves upwards and rotates the one-way clutch (Key "C") which slips in this direction. As the brake torque increases the coil spring (Key "D") load is overcome and the wormshaft is displaced axially, releasing the clone clutch.

When the brake begins its return stroke, the coil spring load returns to normal and the clone clutch is again engaged. The rack is pulled back to its original position in the notch, and any additional travel brought about by lining wear causes the rack to turn the locked one-way clutch and rotates the wormshaft through the locked clone clutch. The wormshaft then rotates the wormwheel and camshaft, adjusting the brakes.

NOTE: Haldex® slack adjusters auto-adjust during brake release.

ROCKWELL® SLACK ADJUSTER

When the service brakes are applied, the chamber push rod extends and rotates the brake slack adjuster, which moves the shoes into contact with the drum. If the normal lining-to-drum clearance is not present, the actuator rod (also connected to clevis) would be forced into the actuator assembly.

As brake application continues, the actuator rod would cause actuator piston to move down and turn the actuator (adjusting sleeve) guided by the pawl teeth. As it turns, the actuator rotates the splined end of the adjusting worm gear. The worm gear turns and rotates the internally splined wormwheel gear, which is attached to the camshaft and adjusts the brakes.

NOTE: Rockwell® slack adjusters auto-adjust during brake applications.

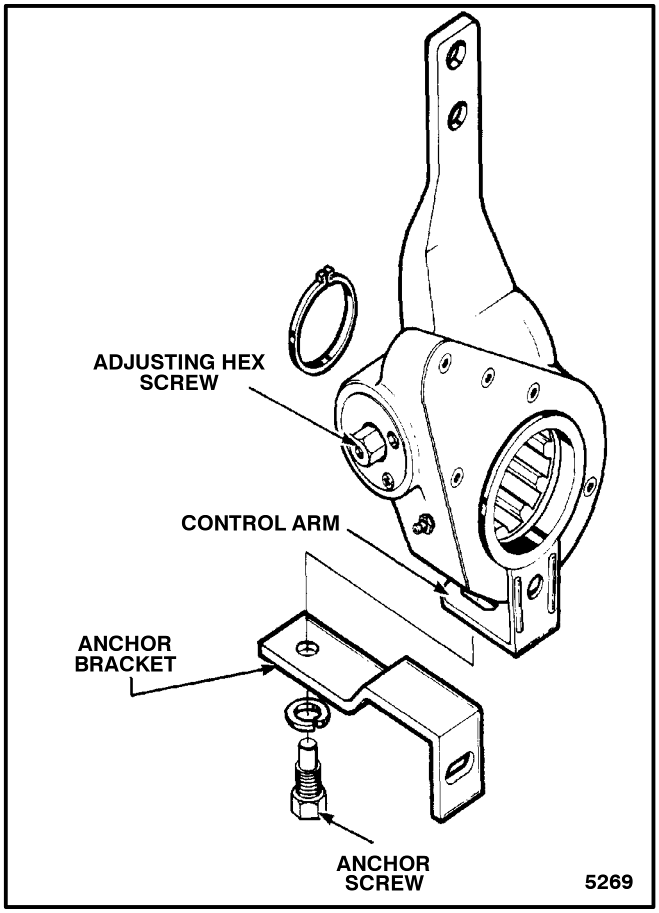


Figure 12. Automatic Slack Adjuster

MAINTENANCE

The Haldex® and Rockwell® automatic slack adjusters have completely sealed actuator mechanisms to ensure maximum service life with minimal maintenance. Some periodic inspection, lubrication and adjustment procedures will be required.

INSPECTION

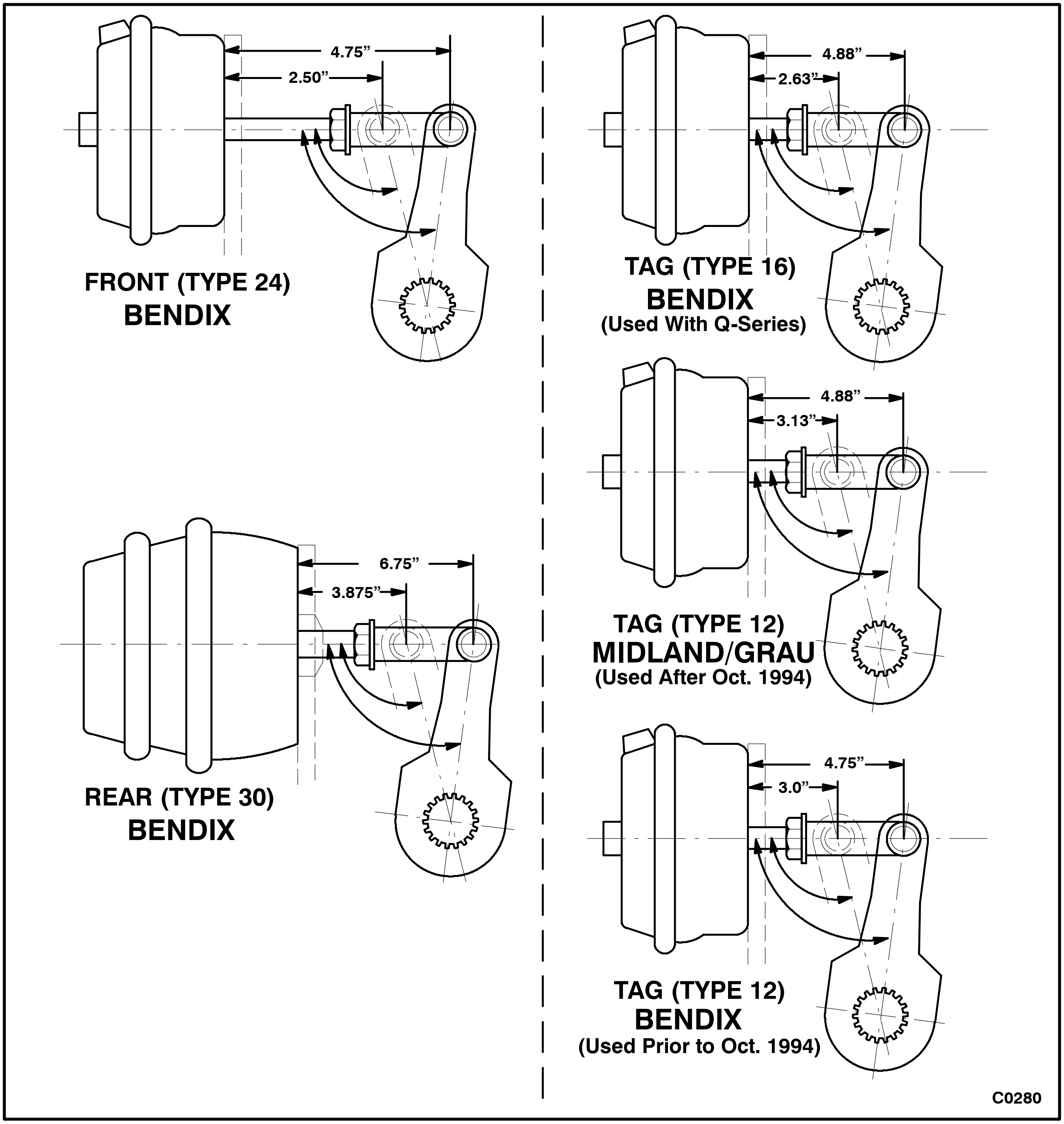
Haldex® automatic slack adjusters are equipped with replaceable wear bushings in the adjuster control arms (Figure 12). ockwell® automatic slack adjusters are fitted with clevis pin bushing in the adjuster arm. Inspection of these bushings should be done at every lube interval and/or brake relining. If any significant wear is evident, remove and replace these bushings.

NOTE: With plastic bushing removed on Haldex® slack adjusters, also inspect the control arm and anchor screw for any wear. If control arm wear exceeds 1/16”, replace adjuster and anchor screw.

1. Apply the coach brakes and inspect that over-stroke indicator is not visible on push rod, and also that slack adjuster rotates freely.

2. Release the brakes and check that slack adjuster and rod return to the released position freely.

All slack adjusters should have an operational check performed during each lubrication interval. Follow the steps in the “Adjustment” procedures below to check for automatic slack adjuster internal mechanism operation.


4.75”
2.50”
FRONT (TYPE 24)
BENDIX
6.75”
3.875”
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BENDIX
4.88”
2.63”
TAG (TYPE 16)
BENDIX
(Used With Q-Series)
4.88”
3.13”
TAG (TYPE 12)
MIDLAND/GRAU
(Used After Oct. 1994)
4.75”
3.0”
TAG (TYPE 12)
BENDIX
(Used Prior to Oct. 1994)
C0280

Figure 13. Push Rod Adjustments

LUBRICATION

Slack adjusters must be lubricated every 5,000 miles (8,000 km) or 150 hours. Lubricate until grease flows out inboard splines (and pawl assembly). Use lubrication specification S-16 or S-19 (Multi-Purpose Grease MOBILITH AW-1 or DARINA EP-1) shown in Section 10.

ADJUSTMENT

NOTE: Step 2 of this procedure is required for the Rockwell® slack adjuster only.

This procedure may be used for either adjusting brakes with existing linings or after replacing linings. Some additional steps are included for making the internal mechanism's operational check.

NOTE: Ensure that the park brake and locking mechanism is released prior to adjusting the rear brakes. Wheels must be jacked and able to turn while adjusting brakes.

1. Position main battery switch to "OFF", and block coach wheels.

2. Remove the pawl assembly from the slack adjuster.

⚠ **CAUTION** ⚠

Rockwell® auto-adjust actuator mechanisms are fitted with an actuator guide pawl. The pawl must be removed (if old style prior to Jan. 1993) or pulled out 1/32" (if new style after Jan. 1993), before turning the adjusting hex screw in either direction. If pawl is not removed, damage to the pawl and actuator guide teeth will occur.

3. Install socket with 1/2" drive ratchet onto the adjusting hex screw of the slack adjuster.

NOTE: To perform the operational check, first manually de-adjust the brakes by turning adjusting hex screw counter-clockwise to create an excessive clearance condition, then continue procedure. To observe adjuster in action, attach a box end wrench to the adjusting hex nut. Any rotation during brake application or release would indicate excessive clearance and that slack adjuster is adjusting for same. Automatic adjustment should decrease on each subsequent braking operation.

4. Turn the adjusting hex screw until the lining contacts the brake drum.

5. Back off the adjustment by turning hex screw one-half turn in the opposite direction.

NOTE: A minimum of 13 ft. lbs. is required to overcome the internal clutch on the slack adjuster. A ratcheting sound will occur when adjuster is operating correctly and rotated in the counter-clockwise direction. If clutch slips at a lesser torque, the adjuster must be replaced.

⚠ **CAUTION** ⚠

Do not use an impact wrench to turn adjusting hex screw as damage will occur to the adjuster mechanism.

6. After adjustments are complete, make a full service brake application (90 to 100 psi.) and check push rod stroke (Figure 13), then release brakes to check lining-to-drum-clearance for proper operation.

NOTE: The air brake chamber push rod stroke can be difficult to measure properly. To determine proper slack adjuster performance, push rod stroke must be accurately measured at a 90 to 100 psi service brake application as recommended by the Commercial Vehicle Safety Alliance (CVSA).

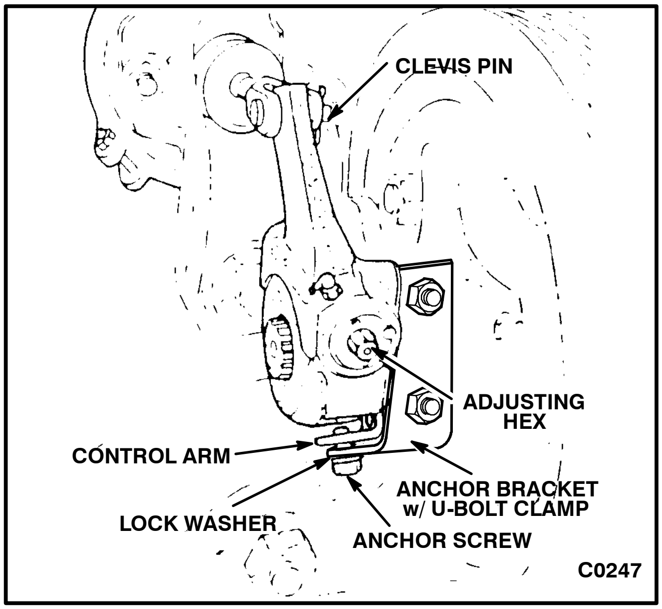

Figure 14. Slack Adjuster Components

REMOVAL

Haldex® Slack Adjuster

1. Position main battery switch to "OFF", block coach wheels, release parking brake.

2. Install a socket with 1/2" drive ratchet onto the adjusting hex screw, and rotate one full turn counter-clockwise to release brakes.

3. Remove the brake chamber push rod clevis pin from slack adjuster arm and remove push rod.

4. Unfasten the anchor screw and disconnect the slack adjuster control arm from its anchor bracket (Figure 14).

5. Unfasten and remove slack adjuster-to-brake camshaft retaining hardware (i.e., capscrew or snap ring).

6. Slide the slack adjuster and spacer washers off the spine end of the camshaft.

NOTE: Mark all spacer washers for reinstalling in their proper positions.

7. Unfasten and remove the anchor bracket from the spider extension if required.

Rockwell® Slack Adjuster

1. Position main battery switch to “OFF”, block coach wheels, release parking brake.

2. Remove the pawl assembly from the slack adjusters.

CAUTION

The pawl must be removed or pulled out before turning the adjusting hex screw. If pawl is not removed, damage to the actuator guide teeth will occur.

3. Install a socket with 1/2” drive ratchet onto the adjusting hex screw, and rotate one full turn counter-clockwise to release brakes.

4. Remove the brake chamber push rod and actuator rod clevis pins from slack adjuster arm and remove push rod.

INSTALLATION

NOTE: Step 2 and steps 7 thru 9 refer to Haldex® installation only. Step 11 refers to the Rockwell® slack adjuster.

1. With main battery switch still “OFF” and wheels blocked, make sure that all brake chamber push rods are fully retracted.

2. Install anchor brackets onto their mounting locations, but do not tighten fasteners fully.

3. Apply anti-seize compound to the camshaft splines.

NOTE: Install slack adjuster onto camshaft splines so arm attachment hole will align with clevis pin hole (approximately one full turn on hex screw).

4. Reinstall any spacer washers on camshaft, and slide slack adjuster onto the end of the camshaft.

NOTE: Install Haldex® slack adjuster with adjusting hex screw pointing away from brake chamber.

5. Install any other spacer washers, and secure slack adjuster with appropriate fasteners.

NOTE: When installing a slack adjuster, clearance must be allowed to ensure that the slack adjuster can be rotated to the maximum stroke of the brake chamber. Install the grease fitting and locate the slack adjuster on the camshaft in such a manner as to allow both the adjuster screw and grease fitting easy access when servicing.

6. Rotate the adjusting hex screw (moving linings outward) to align slack adjuster arm attachment hole with rod clevis, and install the brake chamber push rod clevis pin(s).

NOTE: Slack adjuster may require repositioning on the camshaft spline to achieve correct adjustment.

CAUTION

Do not force the adjuster into position to align the clevis holes. Use only the adjusting nut.

7. Rotate the control arm away from adjusting nut and toward the brake chamber until the control arm reaches a positive internal stop, or until indicator points to notch.

CAUTION

If this control position is incorrect, tight brakes will occur.

8. Position the anchor bracket under the control arm attachment hole, and fix the control arm in this position by installing the anchor screw.

NOTE: Anchor screw must project a minimum of 3/16” into the control arm hole.

CAUTION

Do not use a hammer or any prying tool to achieve hole alignment. To do so will result in improper adjuster installation and/or damage.

9. Tighten the anchor bracket fasteners to the following torques:

A. Clamp type to 30 ft-lbs (40.6 N·m).

B. Angle type to 30–50 ft-lbs (40.6-67.7 N·m)

NOTE: Make sure that control arm position does not move while fasteners are being torqued.

10. Manually adjust the brakes using steps 2 through 5 of the “Adjustment” procedure.

11. Reinstall the pawl assembly into the actuator mechanism and torque to 15-20 ft-lbs (20-27 N·m).

12. Lubricate the slack adjuster and make an “Operational Check” after installation.

TROUBLESHOOTING

1. Air Pressure Drops Quickly With Engine Stopped and Brakes Released

Leaking brake valve tubing or hose line
Leaking elsewhere in the air brake system

2. Air Pressure Drops Quickly With Engine Stopped and Brakes Fully Applied

Leaking brake chamber diaphragm
Leaking brake cylinder or brake valve
Leaking tubing or hose line

3. Brakes Grab

Grease on brake lining - reline brakes
Brake drum out of round
Defective brake valve
Brake rigging binding

4. Insufficient Brakes

Brakes need adjusting, lubricating or relining
Low air pressure in brake system below 80 psi (522 kPa)
Brake valve delivery pressure below normal

5. Brakes Apply Too Slowly

Brakes need adjusting or lubricating
Low air pressure in the brake system - below 80 psi (522 kPa)
Brake valve delivery pressure below normal
Excessive leakage with brakes applied
Restricted tubing or hose line

6. Brakes Release Too Slowly

Brakes need adjusting or lubricating
Brake valve not returning to fully released position
Restricted tubing or hose line
Exhaust port of brake valve or quick release valve restricted or plugged
Defective brake valve or quick release valve

7. Brakes Do Not Apply

No air pressure in brake system
Restricted or broken tubing or hose line
Defective brake valve

8. Brakes Do Not Release

Brake rigging binding
Brake valve not in fully released position
Defective brake valve
Restriction in tubing or hose line

9. Uneven Brakes

Brakes need adjusting, lubricating or relining
Grease on brake lining – reline brakes
Brake shoe release spring or brake chamber release spring broken
Brake drum out of round
Brake chamber diaphragm leaking

SPECIFICATIONS

BRAKE LINING KITS (W-SERIES)

Manufacturer	Rockwell International (ABEX 931-162)
Part Number (Front)	4K-1-13
Part Number (Rear)	4J-4-26
Part Number (Trailing)	4K-1-13

BRAKE LINING KIT (Q-SERIES)

Manufacturer	Rockwell International (Specification ABEX 931-162)
Part Number (Trailing 15” x 4”)	4L-4-154

BRAKE CAMSHAFT KIT (Q-SERIES)

Manufacturer	Rockwell International
Part Number (Trailing 15” x 4”)	4L-4-155

BRAKE SPRING KIT (Q-SERIES)

Manufacturer	Rockwell International
Part Number (Trailing 15” x 4”)	4L-4-156

BRAKE SHOE MOUNTING KIT (Q-SERIES)

Manufacturer	Rockwell International
Part Number (Trailing 15” x 4”)	4L-4-157

BRAKE DRUMS (W-SERIES)

Manufacturer	Rockwell International
Part Number (Front 14.5” x 5”)	15J-2-35 (Balanced)
Part Number (Rear 14.5” x 8”)	15J-3-41
Part Number (Trailing 14.5” x 5”)	15F-5-1

BRAKE DRUMS (Q-SERIES)

Manufacturer	Rockwell International
Part Number (Trailing 15” x 4”)	4L-4-72

BRAKE CHAMBERS - FRONT

Part Number (W-Series Brakes) (Used Prior To Oct. 1994)	4J-2-15 (RH) 4J-2-16 (LH)
Manufacturer	Bendix
Type	24
Diameter	7-1/4” (184.1 mm)
Stroke	2-1/4” (57.1 mm)
Effective Area	24 sq. in.(154.8 sq. cm)

BRAKE CHAMBERS - FRONT

Part Number (W-Series Brakes) (Effective With Oct. 1994)	4L-2-14 (RH) 4L-2-13 (LH)
Manufacturer	Bendix
Type	24
Diameter	7-3/8” (187.3 mm)
Stroke	2-1/4” (57.1 mm)
Volume	58.5 cu in.(377.4 cu. cm)

BRAKE CHAMBERS - REAR

Part Number	4R-5-1 (RH/LH)
Manufacturer	Bendix
Type	30 - DD3
Diameter	8-1/8” (206.3 mm)
Stroke	2-7/8” (73.0 mm)
Effective Area (Service)	30 sq. in.(193.5 sq. cm)

BRAKE CHAMBERS - TRAILING

Part Number (W-Series Brakes) (Used Prior To Oct. 1994)	4R-5-3 (RH/LH)
Manufacturer	Bendix
Type	12
Diameter	5-21/32” (143.6 mm)
Stroke	1-3/4” (44.4 mm)
Effective Area	12 sq. in. (77.4 sq. cm)

BRAKE CHAMBERS - TRAILING

Part Number (W-Series Brakes) (Effective With Oct. 1994)	4L-5-17 (RH) 4L-5-18 (LH)
Manufacturer	Midland/Grau
Type	12
Diameter	5-3/4” (146. mm)
Stroke	1-3/4” (44.4 mm)
Volume	24 cu in..(154.8 cu. cm)

BRAKE CHAMBERS - TRAILING

Part Number (Q-Series Brakes)	4L-5-3 (RH/LH)
Manufacturer	Bendix
Type	16
Diameter	6-1/2” (165.1 mm)
Stroke	2-1/4” (57.1 mm)
Volume	43 cu in.(309.6 cu. cm)

SLACK ADJUSTER - FRONT

Part Number (Bendix - Manual)	4R-3-15 (LH) 4R-3-16 (RH)
Part Number (Haldex - Automatic)	4L-3-14 (LH) 4L-3-13 (RH)

SLACK ADJUSTER - REAR

Part Number (Bendix - Manual)	4L-6-24 (RH/LH)
Part Number (Rockwell - Automatic)	4L-6-25 (LH) 4L-6-26 (RH)
Part Number (Haldex - Automatic)	4L-6-27 (RH/LH)

SLACK ADJUSTER - TRAILING

Part Number (W-Series Brakes) (Bendix - Manual 102D3 Only)	4M-6-3 (RH/LH)
Part Number (W-Series Brakes) (Haldex - Automatic 102D3 Only)	4F-6-5 (RH/LH)
Part Number (Q-Series Brakes) (Haldex - Automatic 102D3 Only)	4L-6-49 (RH/LH)
Part Number (Q-Series Brakes) (Rockwell - Automatic 102D3 Only)	4L-6-48 (RH/LH)

SECTION 4C2

DISC BRAKES

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GENERAL DESCRIPTION

Some D series coaches may be optionally equipped with Rockwell® Dura-Master ADB-1560 series air disc brake assemblies on the front and trailing axle installations. They are air-operated, wormscrew-driven, piston-actuated, dual shoe, heavy-duty, internal rotor, compressing type brake assemblies.

The brake assemblies are mounted at the axle ends. The brakes are sized (diameter & pad area) specifically to each axles brake specification. These brake assemblies feature all metal construction, and non-asbestos linings for long service life.

COMPONENTS

The Dura-Master air disc brake assembly contains several major components (Figure 1 & 2). All of these major components will be discussed, and some other related parts such as the hubs will also be addressed.

⚠ CAUTION ⚠

The Dura-Master air disc brake assemblies are made to be used with Rockwell® approved automatic slack adjusters only. Do not install a manual slack adjuster to the disc brake assemblies.

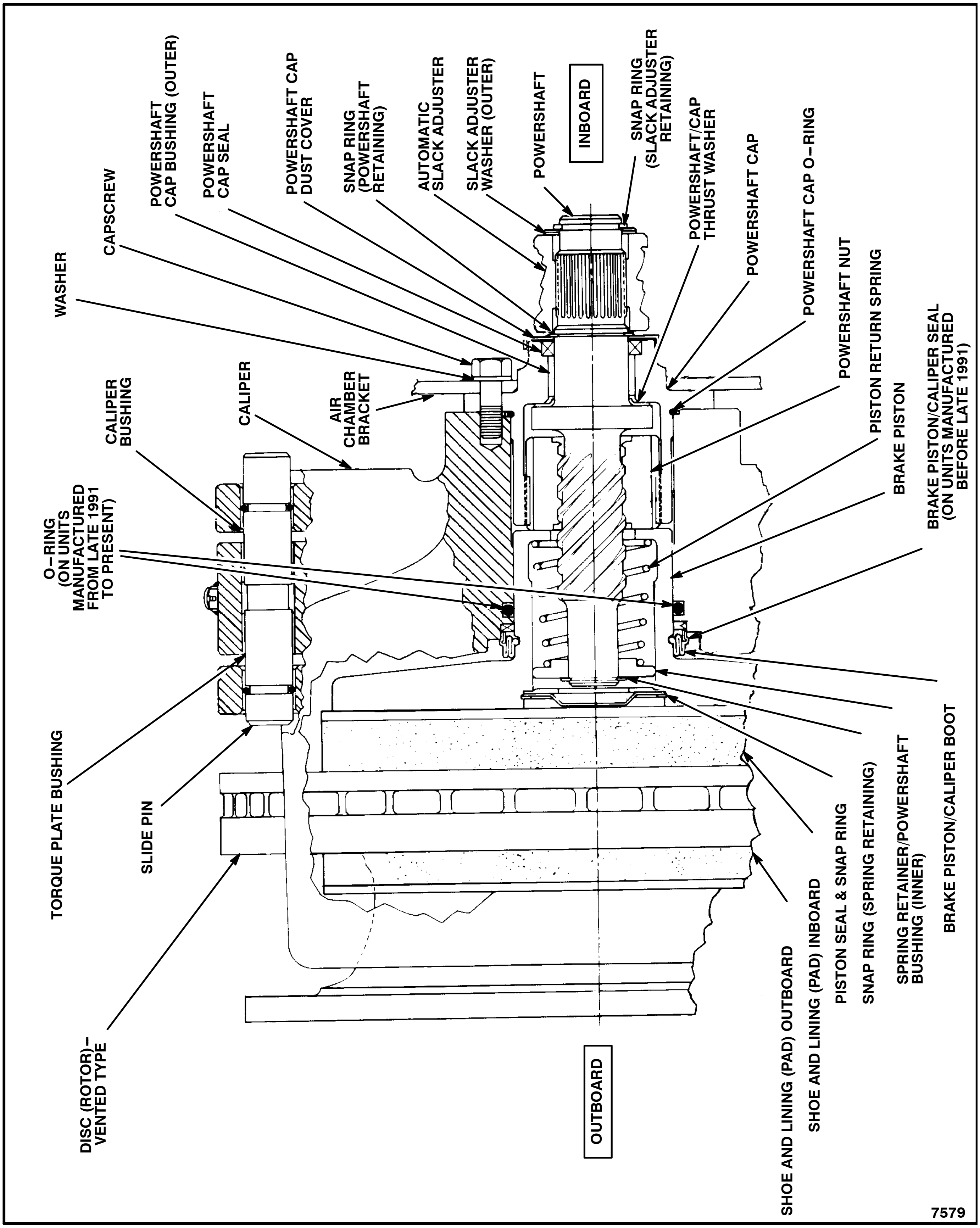
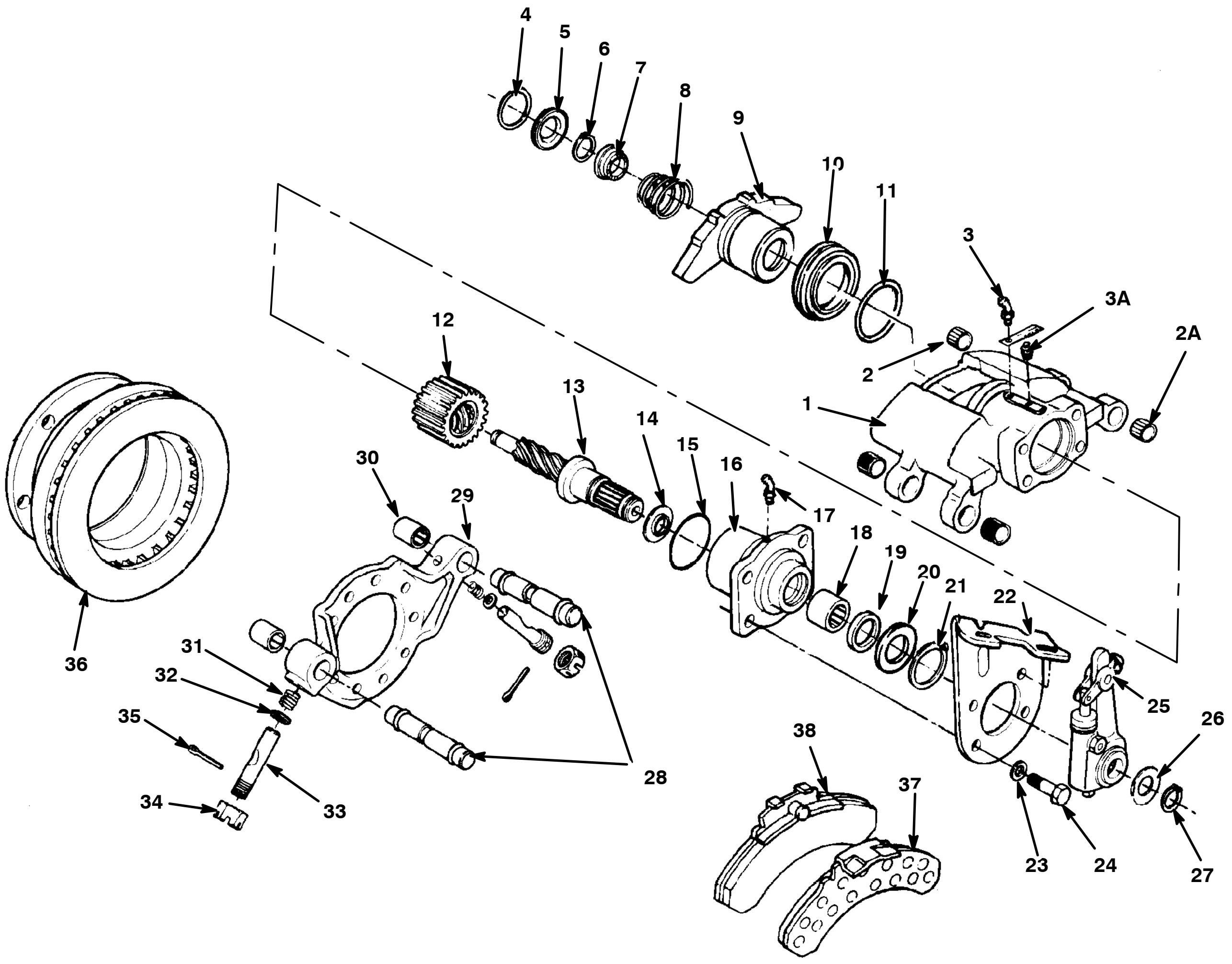

WASHER
CAPSCREW
POWERSHAFT CAP BUSHING (OUTER)
POWERSHAFT CAP SEAL
POWERSHAFT CAP DUST COVER
SNAP RING (POWERSHAFT RETAINING)
AUTOMATIC SLACK ADJUSTER
SLACK ADJUSTER WASHER (OUTER)
POWERSHAFT
INBOARD
SNAP RING (SLACK ADJUSTER RETAINING)
POWERSHAFT/CAP THRUST WASHER
POWERSHAFT CAP
POWERSHAFT CAP O−RING
POWERSHAFT NUT
PISTON RETURN SPRING
BRAKE PISTON
BRAKE PISTON/CALIPER SEAL (ON UNITS MANUFACTURED BEFORE LATE 1991)
CALIPER BUSHING
CALIPER
AIR CHAMBER BRACKET
O−RING (ON UNITS MANUFACTURED FROM LATE 1991 TO PRESENT)
TORQUE PLATE BUSHING
SLIDE PIN
DISC (ROTOR)− VENTED TYPE
OUTBOARD
SHOE AND LINING (PAD) OUTBOARD
SHOE AND LINING (PAD) INBOARD
PISTON SEAL & SNAP RING
SNAP RING (SPRING RETAINING)
SPRING RETAINER/POWERSHAFT BUSHING (INNER)
BRAKE PISTON/CALIPER BOOT
7579

Figure 1. Air Disc Brake Cutaway



ITEM	DESCRIPTION
1	CALIPER
2	BUSHING–CALIPER SLIDE PIN (OUTER)
2A	BUSHING–CALIPER SLIDE PIN (INNER)
3	FITTING–GREASE
3A	FITTING–PRESSURE RELIEF
4	SNAP RING–SEAL RETAINING
5	SEAL ASSEMBLY–BRAKE PISTON END
6	SNAP RING–SPRING RETAINING
7	BUSHING–POWERSHAFT INNER PILOT
8	SPRING–PISTON RETURN
9	PISTON–BRAKE SHOE
10	BOOT–CALIPER/PISTON
11	O–RING–BRAKE PISTON TO CALIPER
12	NUT–ACTUATOR
13	POWERSHAFT
14	WASHER–POWERSHAFT THRUST
15	O–RING
16	CAP–POWERSHAFT
17	FITTING–GREASE
18	BUSHING–POWERSHAFT
19	SEAL–POWERSHAFT CAP
20	DUST COVER–POWERSHAFT RETAINING
21	SNAP RING–POWERSHAFT RETAINING
22	BRACKET–AIR CHAMBER
23	WASHER–CHAMBER BRACKET CAPSCREW
24	CAPSCREW–CHAMBER BRACKET
25	AUTOMATIC SLACK ADJUSTER
26	WASHER–SLACK ADJUSTER
27	SNAP RING–SLACK ADJUSTER
28	SLIDE PIN–CALIPER
29	TORQUE PLATE
30	BUSHING–TORQUE PLATE
31	SPRING–SLIDE PIN RETAINER
32	WASHER–SLIDE PIN RETAINER
33	SLIDE PIN RETAINER
34	NUT–SLIDE PIN RETAINER
35	COTTER PIN–SLIDE PIN RETAINER
36	DISC (ROTOR) VENTED TYPE
37	SHOE AND LINING ASSEMBLY (INNER)
38	SHOE AND LINNING ASSEMBLY (OUTER)

7578

Figure 2. Air Disc Brake Components

LINING

The linings are made of high-friction composite type materials for superior coach braking performance. The brake linings are the components most likely to require servicing. One bonded lining pad is required for each brake shoe.

NOTE: The disc brake assemblies incorporate lining wear indicators for quick maintenance checks.

BRAKE SHOE

The two (2) brake shoes are located on the inner and outer upper rotor surfaces. The shoes are attached to the caliper piston by spring clips, and or guided by the piston and caliper. The brake shoes are returned to their normal position by an internal piston return spring.

TORQUE PLATE

The steel torque plate assembly holds the caliper in position at all times via the slide pins, and is the only brake component rigidly attached to the axle. The torque plate provides mounting holes for the slide pin bushings, slide pin retainers and axle attaching bolts.

NOTE: All torque plate installations require the addition of an inner brake chamber mounting bracket.

POWERSHAFT

The powershaft actuator rotates inside the powershaft cap and piston assemblies. The powershaft design allows connection of the slack adjuster to the splined end, while the wormscrew end turns forcing the actuator nut and piston to move. Related serviceable components of the powershaft are the thrust washer, bushing and seals.

PISTON

The piston is the actuator component of the disc brake assembly. The piston moves the brake shoe and lining out against the rotor, guided by slide grooves in the caliper. The piston houses the return spring and powershaft bushing.

CALIPER

The disc brake caliper houses the internal actuating components. The caliper groove design maintains correct brake shoe contact with the rotor. The caliper rides on two slide pin assemblies which allow for self-aligning of shoes to rotor during actuation. The powershaft cap and brake chamber bracket is mounted to the caliper.

HUB AND ROTOR ASSEMBLY

The disc brake hub is bolted to a machined flange and vented rotor assembly. The vented rotors are designed to allow the brake shoe linings to ride against the inner and outer surfaces while being actuated. Both the front and trailing rotors are a nominal fifteen (15) inches in diameter.

OPERATION

During service brake application, the push rod extends and pushes the slack adjuster. This causes the slack adjuster to rotate, thereby making the powershaft rotate. This rotation makes the powershaft actuator nut slide out along the powershafts wormscrew. The actuator nut pushes the piston and inboard brake lining outward against the rotor.

The force of the inboard shoe and lining on the rotor pulls the caliper inward along the slide pins. This movement of the caliper puts the outboard shoe and lining into contact with the rotor. The resulting clamping force on both sides of the rotor produces friction and stops the wheel.

When the brakes are released, the piston return spring retracts the piston, which forces the actuator nut back in to the at rest position. This action releases the clamping force on the rotor.

NOTE: Depending on axle installation and/or brake assembly orientation powershaft actuating rotations could be clockwise or counter-clockwise.

MAINTENANCE

NOTE: Some procedures require the use of special tools. Failure to use these tolls when required, may cause personnel injury or component damage. Kent-Moore tool kit J-34064-B or its equivalent is recommended. Proper shop safety procedures are required at all times. The tool kits are available from:

Kent-Moore Heavy Duty Division
29784 Little Mack
Roseville, Michigan 48066-2298

⚠ WARNING ⚠

The composition of non-asbestos brake linings may contain glass, mineral wool, aramid, ceramic or carbon fibers. Long-term exposure to these types of fibers may cause pneumoconioses, fibrosis and/or cancer. Use caution to avoid the dust from the non-asbestos brake linings when working on them.

The guidelines listed below should be followed to minimize exposure to non-asbestos brake lining dust and particles.

1. Whenever possible, work on brakes in a separate area away from other operations.

2. Always wear a respirator approved by NIOSH or MSHA during all brake service procedures. Wear the respirator from the removal of the wheels through assembly.

3. NEVER use compressed air or dry brushing to clean brake parts or assemblies. OSHA recommends using cylinders that enclose the brake. These cylinders have vacuums with high-efficiency (HEPA) filters and workmen's arm sleeves. If such equipment is not available, carefully clean parts and assemblies in the open air.

4. Clean brake parts and assemblies in the open air. During disassembly, carefully place all parts on the floor to avoid getting dust into the air. Use an industrial vacuum cleaner with a HEPA filter system to clean dust from brake drums, backing plates and other brake parts. After using the vacuum, remove any remaining dust with a rag soaked in water and wrung nearly dry.

5. If it is necessary to grind or machine brake linings, additional precautions should be taken because contact with fiber dust is higher during these operations. In addition to wearing an approved respirator, such work should be done in an area with exhaust ventilation.

6. When cleaning the work area, NEVER use compressed air or dry sweeping. Use an industrial vacuum cleaner with a HEPA filter and rags soaked in water and wrung nearly dry. Used rags should be disposed of with care to avoid getting dust into the air. Use an approved respirator while emptying vacuum cleaners and handling used rags.

7. After working on the brake system, workers should wash their hands before eating or drinking. Work clothes should not be worn home. Work clothes should be vacuumed after use and then laundered separately, without shaking, to prevent getting fiber dust into the air.

⚠ WARNING ⚠

Wear safe eye protection at all times while performing brake maintenance to prevent serious personal injury

A periodic schedule for the inspection, cleaning and adjustment of brake components should be established depending on specific usage and the wear characteristics encountered by such usage.

LUBRICATION

⚠ CAUTION ⚠

The lubrication procedures for the Dura-Master air disc brake components are extremely important. Failure to strictly follow these procedures could result in premature lining failure or brake damage.

NOTE: See Section 10 "Lubrication" and service bulletin #2625 for complete information on lubrication specifications used on the disc brakes.

These procedures require that some brake components be partially disassembled. See the "Removal" and "Disassembly" procedures for these components later in this section.

Internal Components

The internal components of the disc brake calipers require lubrication two to four times during the life of the lining or every six (6) months. Lubricate these components through the fittings provided on the caliper and or powershaft cap.

1. Position main battery switch to "OFF", apply park brake and block coach wheels not being serviced.

2. Jack coach and secure with stands before removing wheel.

3. Remove or disengage the pawl assembly from the slack adjuster.

⚠ CAUTION ⚠

Rockwell® automatic slack adjuster actuator mechanisms are fitted with an actuator guide pawl. The pawl must be removed (old style prior to Jan. 1993) or disengaged by pulling out 1/32" (new "Pull Pawl" style after Jan. 1993), before turning the adjusting hex screw in any direction. If pawl is not removed, damage to the pawl and actuator guide teeth will occur. "Pull Pawl" design automatically engages after it is released.

4. Install socket with 1/2 inch drive ratchet onto the adjusting hex screw of the slack adjuster.

5. Turn the adjusting hex screw until the inboard lining contacts the rotor.

6. Plug the pressure relief valve by holding a finger over the poppet, and apply grease until it flows out of seal in the powershaft cap.

NOTE: On calipers with two grease fittings, apply grease to the caliper fitting first, and then to the fitting on the powershaft cap (Figure 3).

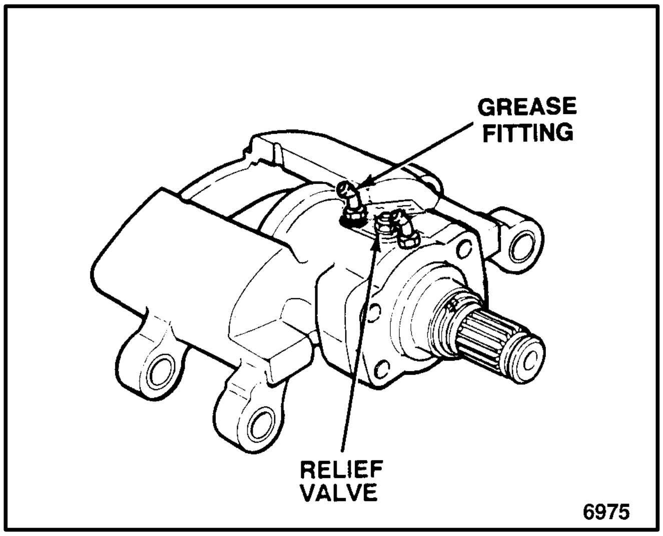


Figure 3. Caliper Grease Fittings

7. Remove the pressure relief valve, and fully retract the piston. Grease should flow out of the relief hole.

CAUTION

Step 7 must be done to force any excess grease from the caliper. Too much grease or air inside the caliper can cause the linings to drag on the rotor and damage the brakes.

8. Wipe caliper clean, reinstall the pressure relief valve and torque to 10 ft-lbs (13.5 N·m).

9. Adjust the brakes and reinstall or engage the slack adjuster pawl.

NOTE: If the coach is to be serviced by untrained personnel, consider removing the grease fittings and plug holes to eliminate the possibility of over-greasing or of incorrect grease being used.

External Components

Other external components such as slide pin retainers also require lubrication. These components should be lubed during brake relining or when brakes are repaired.

1. Follow steps 1 thru 5 of the above procedure.
2. Follow the "Caliper Disassembly" procedure that follows to remove the slide pin retainers (Figure 4).
3. Apply anti-seize compound to the slide pin retainer and reinstall.

NOTE: Do not apply anti-seize compound to the threads on the slide pin retainer nor to the slide pin itself.

4. Reinstall the slide pin, assemble the brakes, test and clean any excess lube material from the slide pins.

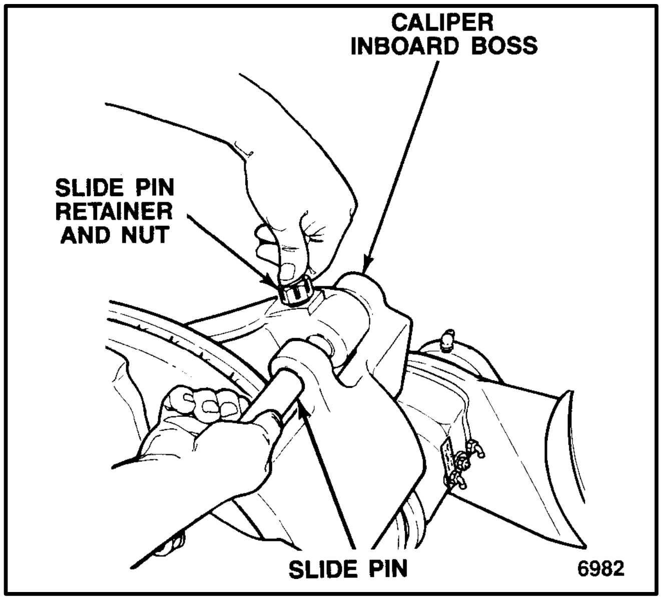


Figure 4. Removing Slide Pin

ROTOR INSPECTIONS

When inspecting or relining the brakes, the rotor thickness should be measured and both surfaces inspected for the following conditions:

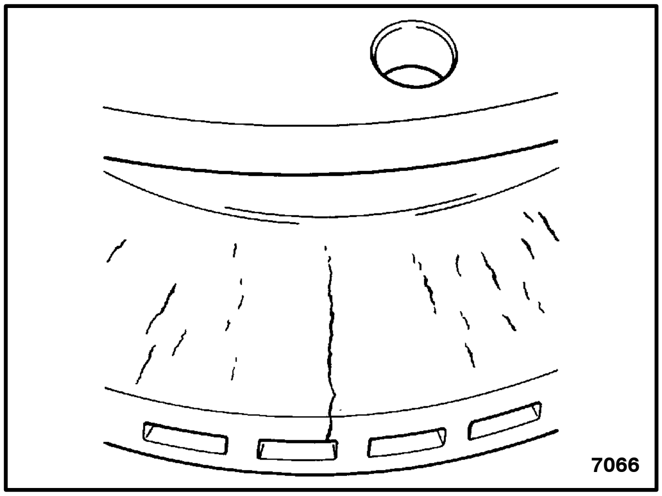


Figure 5. Rotor with Cracks

Cracks

A crack can extend through a section of the rotor, and, when heated through normal braking they can open and separate damaging the brakes (Figure 5).

Heat Checking

Heat checking is caused by heat and appears as cracks in the surface of the rotor. There are two categories of heat checking, light and heavy (Figure 6).

Light heat checking is very fine, tight cracks. Light heat checking is normal. A rotor with light heat checking can continue to be used. Heavy heat checking is evident by surface cracks that have width and depth and extend some distance.

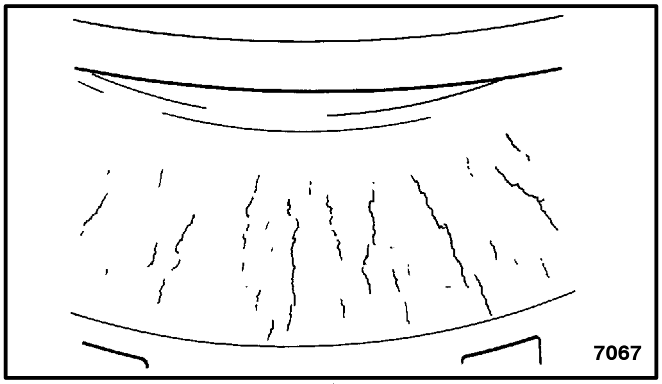


Figure 6. Rotor with Heat Checking

Grooves Or Scores

Check booth sides of the rotor for deep grooves or scores (Figure 7). If the grooves or scores are not too deep, the rotor may continue to be used. If the grooves or scores are deep, replace the rotor.

⚠ WARNING ⚠

If any cracks, heavy heat checking or deep groves are found, always replace the rotor. Always replace a damaged rotor.

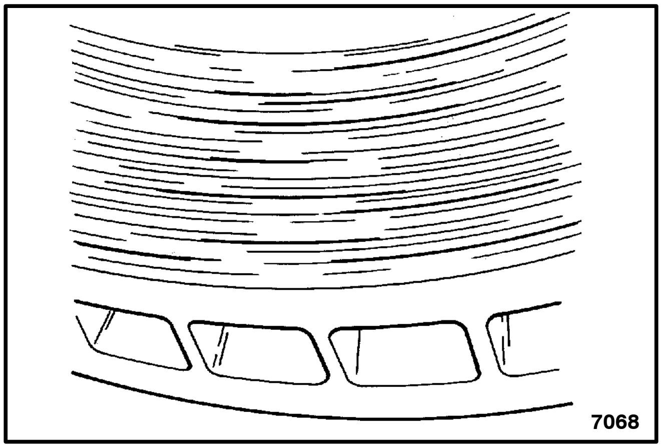


Figure 7. Rotor with Grooves and Scores

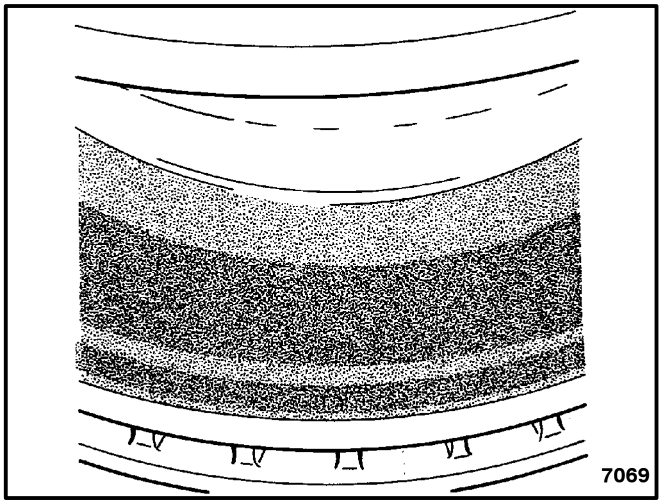


Figure 8. Rotor with Blue Bands and Marks

Bluing

Blue marks or bands indicate that the rotor had gotten very hot (Figure 8). If blue marks or bands are present, use the troubleshooting guide to find and correct the cause of the problem.

Machining Tolerances

Measure the thickness of the rotor when relining the brakes. The rotor must be at least 1.626 inches (41.3 mm) thick (Figure 9). Replace the rotor if the thickness is less than specified.

Original Thickness	Minimum Thickness
1.750 (Nominal)	1.626

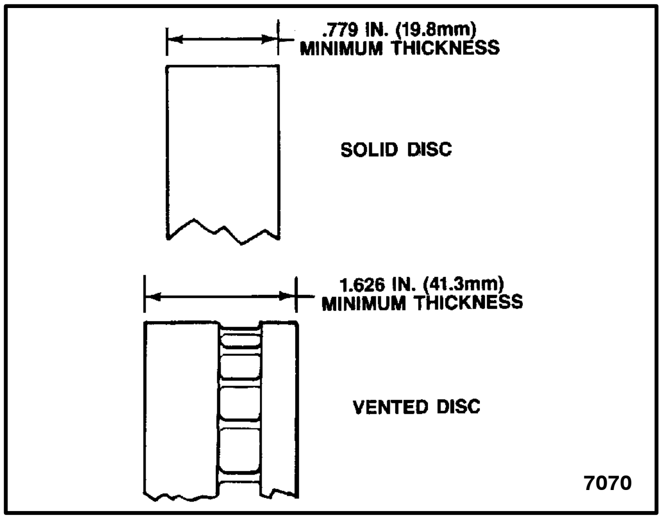


Figure 9. Rotor Thickness

⚠ WARNING ⚠

Under no circumstances should rotors be used when machined beyond the minimum allowable dimension.

ROTOR REMOVAL & DISASSEMBLY

NOTE: The hub and rotor must be removed as an assembly and then disassembled to service the rotor.

1. Position main battery switch to "OFF", apply park brake and block coach wheels not being serviced.
2. Jack coach and secure with stands before removing wheel.
3. Drain all oil from the oil lubricated hubs.
4. Disassemble brakes and remove the caliper using the "Caliper Removal" procedure.
5. Remove the jam nut, washer and adjusting nut from the spindle (Figure 10).

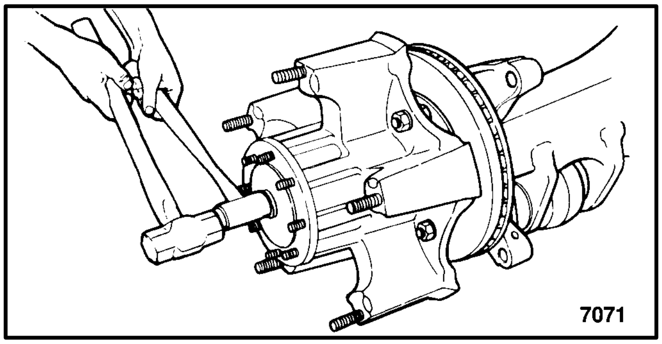


Figure 10. Removing Spindle Nut

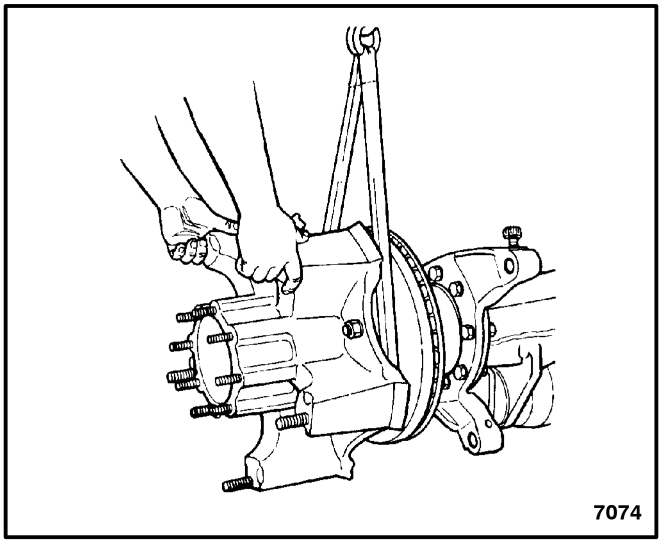


Figure 11. Hub & Rotor Assembly Removal

6. Attach a strap or other lifting device to support the rotor and hub assembly during removal (Figure 11).
7. Remove the wheel stud flanged nuts, and separate the rotor from the hub (Figure 12).

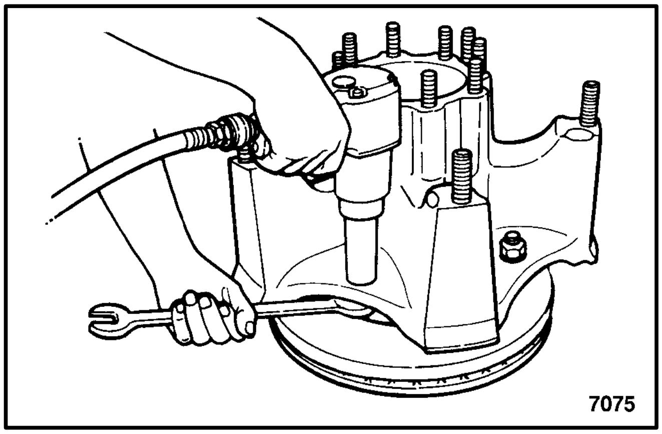


Figure 12. Separating Hub and Rotor

ROTOR ASSEMBLY & INSTALLATION

1. Place the rotor spool on a bench (rotor disc side down), and position the hub assembly to align holes.
2. Insert studs and attach flanged nuts (Figure 13). Using a crisscross pattern torque nuts to 110-130 ft-lbs (149-176 N·m)
3. Use a strap or other lifting device to install the rotor and hub assembly onto the spindle (Figure 14).
4. Refill the hub with lubricant. Refer to Section 1 or 15 for the correct lubrication procedure and specifications.
5. Reinstall the jam nut, washer and adjusting nut, and adjust wheel bearing per "Adjustment" procedure in Section 15.

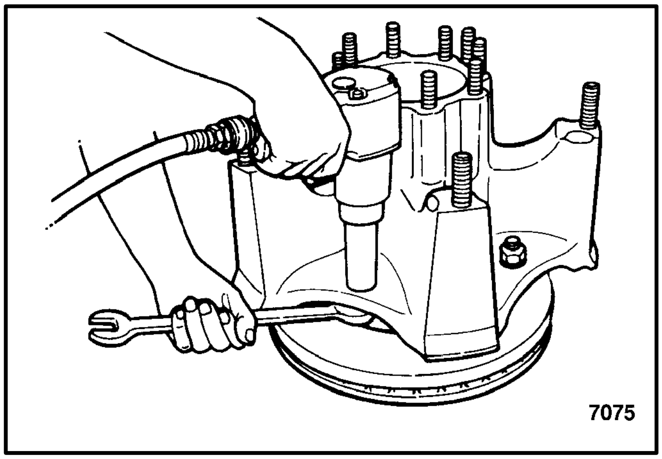


Figure 13. Assemble Hub and Rotor

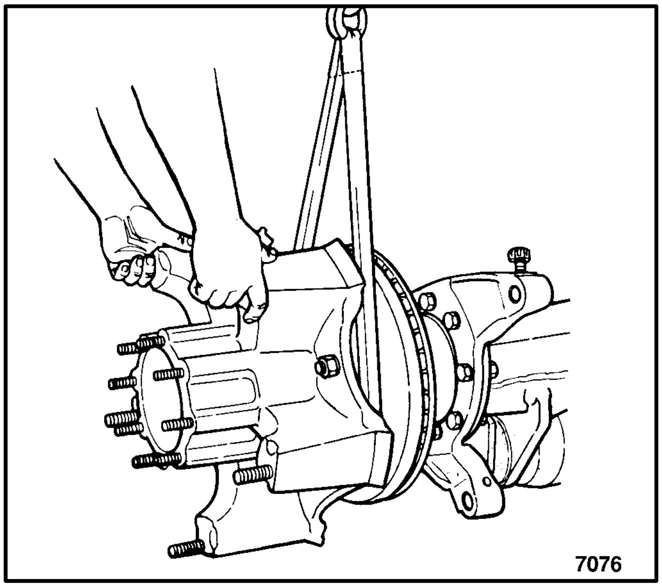


Figure 14. Install Rotor & Hub Assembly

BRAKE LINING REMOVAL

CAUTION

Linings vary considerably in size and in composition. They should be replaced only with OEM linings listed in the MCI Parts Manual.

1. Position main battery switch to “OFF”, apply park brake and block coach wheels not being serviced.

2. Jack coach and secure with stands before removing wheel.

3. Remove or disengage the pawl assembly from the slack adjuster.

CAUTION

Rockwell® automatic slack adjuster actuator mechanisms are fitted with an actuator guide pawl. The pawl must be removed (old style prior to Jan. 1993) or disengaged by pulling out 1/32” (new “Pull Pawl” style after Jan. 1993), before turning the adjusting hex screw in any direction. If pawl is not removed, damage to the pawl and actuator guide teeth will occur. “Pull Pawl” design automatically engages after it is released.

4. Install socket with 1/2 inch drive ratchet onto the adjusting hex screw of the slack adjuster.

5. Turn the manual adjusting nut on the slack adjuster until the brake piston is completely retracted.

6. Pull cotter pin, loosen the nut on the upper slide pin retainer and remove the retainer and slide pin (Figure 15).

NOTE: Refer to the slide pin removal steps shown in the “Caliper Removal” procedure that follows.

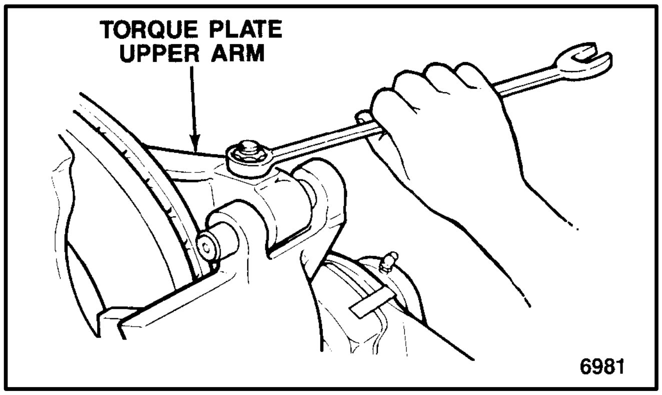


Figure 15. Slide Pin Retainer

WARNING

Wear safe eye protection if the slide pins require hitting to loosen them. Do not hit these parts with a steel hammer. The steel parts can break and cause serious personal injury. Use a brass mallet.

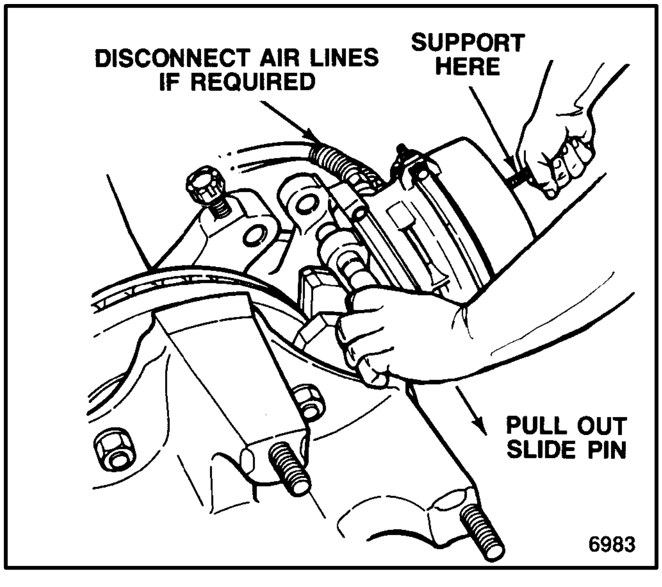


Figure 16. Supporting Caliper

CAUTION

Do not support the caliper and the air chamber with the air lines or damage can occur to the air lines. If the air lines are not long enough to move the caliper completely down, disconnect the air lines.

7. Support the caliper at the air chamber while removing the slide pin. Hold the air chamber and lower the caliper (Figure 16).

8. Remove the outer pad first by pressing down on the end of the pad to compress the clip and slide the pad over to the notches. Repeat for the inner pad (Figure 17).

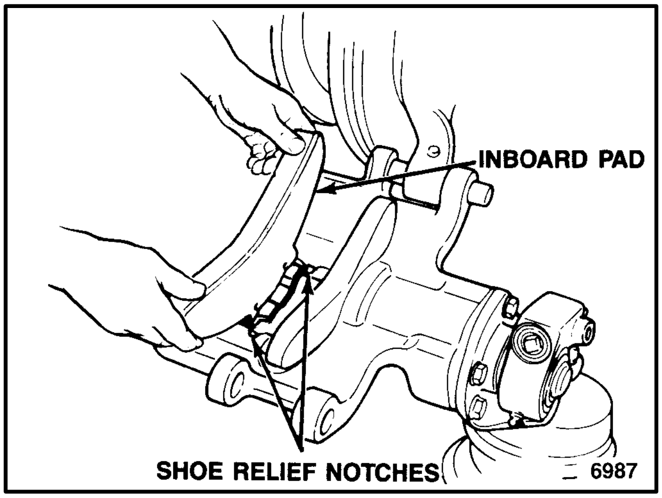


Figure 17. Removing Outer Pad

INSPECTION

Before installing new pads, make the following inspections. Replace any components that are worn or damaged. Refer to the components applicable removal and installation procedures that follow.

1. Check for grooves worn in the caliper by the brake shoe tabs (Figure 18).

NOTE: A caliper that is worn will not hold the pad assemblies in position. If the caliper is worn more than 0.015-inch (0.38 mm) on either side, replace the caliper.

2. Turn the manual adjusting nut on the slack adjuster to extend the piston and boot approximately one inch (25 mm) (Figure 19).

3. Use a clean rag to remove any dirt or grease from the boot, and inspect for cuts, tears or cracks. If the boot is damaged, install a new boot and seal.

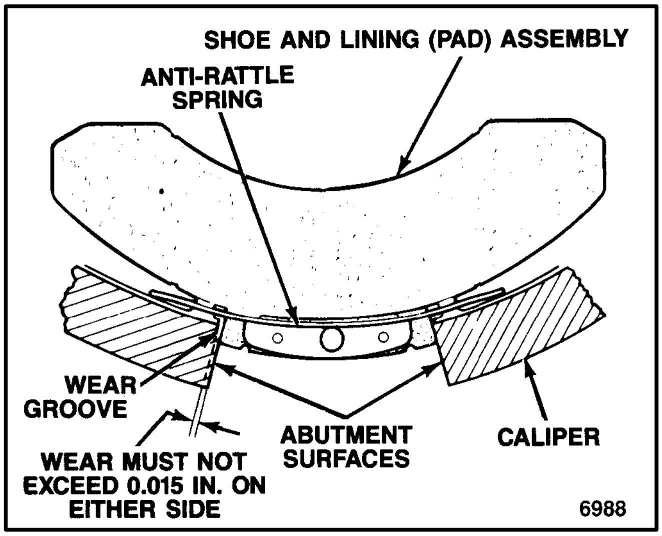

SHOE AND LINING (PAD) ASSEMBLY
ANTI-RATTLE SPRING
WEAR GROOVE
WEAR MUST NOT EXCEED 0.015 IN. ON EITHER SIDE
ABUTMENT SURFACES
CALIPER
6988

Figure 18. Caliper Wear

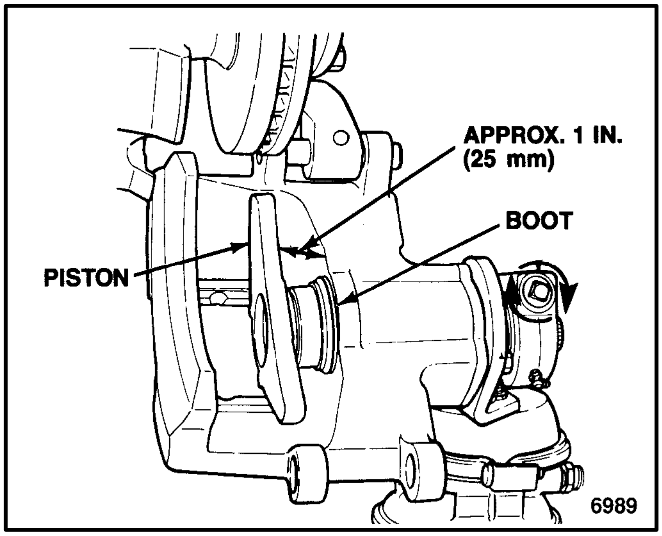


Figure 19. Piston And Boot Extension

4. Clean, inspect and measure the slide pins and bushings.

A. Remove any paint, dried lube or other material from the pins. Replace the pins if burrs, nicks, corrosion, or other damage is found.

B. Measure the diameter of the pins with a micrometer. Replace the pins if the diameter is less than 0.987 inch (25.07 mm).

C. Clean, inspect and measure the bushings in the caliper.

D. Repeat these checks for the lower slide pin and bushings after installing new linings and installing the caliper.

5. Inspect the rotor for damage, and measure the thickness of the rotor. Replace the rotor if it is damaged or if its dimensions are not within specifications.

6. Do the following to the automatic slack adjuster;

A. Inspect the boot for cuts or damage. Replace the boot if required.

B. Remove the pawl and inspect the grease inside the slack adjuster.

NOTE: If the grease is in good condition, finish relining the brakes.

BRAKE LINING INSTALLATION

1. Make sure that the brake piston is still retracted. If necessary, push the piston completely into the caliper.

NOTE: On brakes with vented rotors, the inboard pad is thicker than the outboard pad. On brakes with solid rotors, the inboard and outboard pads are the same thickness. Make sure to install the pads in the correct positions with the linings toward the rotor.

⚠ CAUTION ⚠

Do not hit the pads with a hammer to force them into place or damage can occur to the pads.

2. Install the inboard pad first. Fit the shoe tab into the notches in the caliper (Figure 20). Push down on the edge of the pad to compress the clip and slide the pad against the piston.

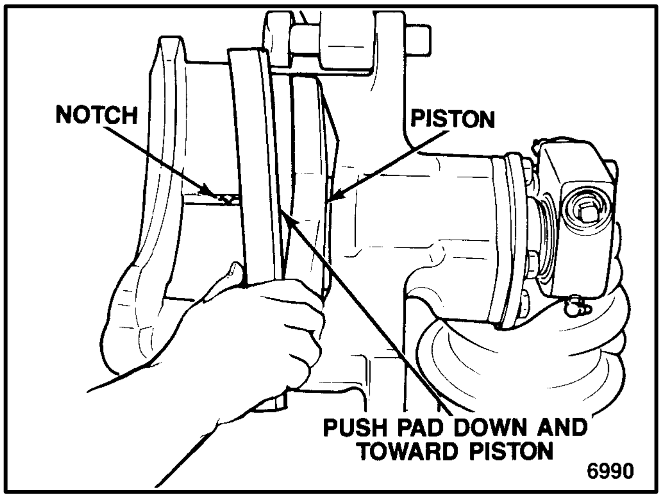


Figure 20. Inboard Pad Installation

NOTE: If necessary, use a screwdriver to compress the clip while sliding the pad against the piston (Figure 21).

3. Repeat step 2 to install the outboard pad. Slide the outboard pad against the outer leg of the caliper.

⚠ CAUTION ⚠

For the brake to work properly, the back of the inboard pad must fit flat against the piston and the pad must slide in the caliper. The back of the outboard pad must fit flat against the outer leg of the caliper. If the pads do not slide or fit correctly, repair any burrs, nicks or other damage on the shoes or the caliper.

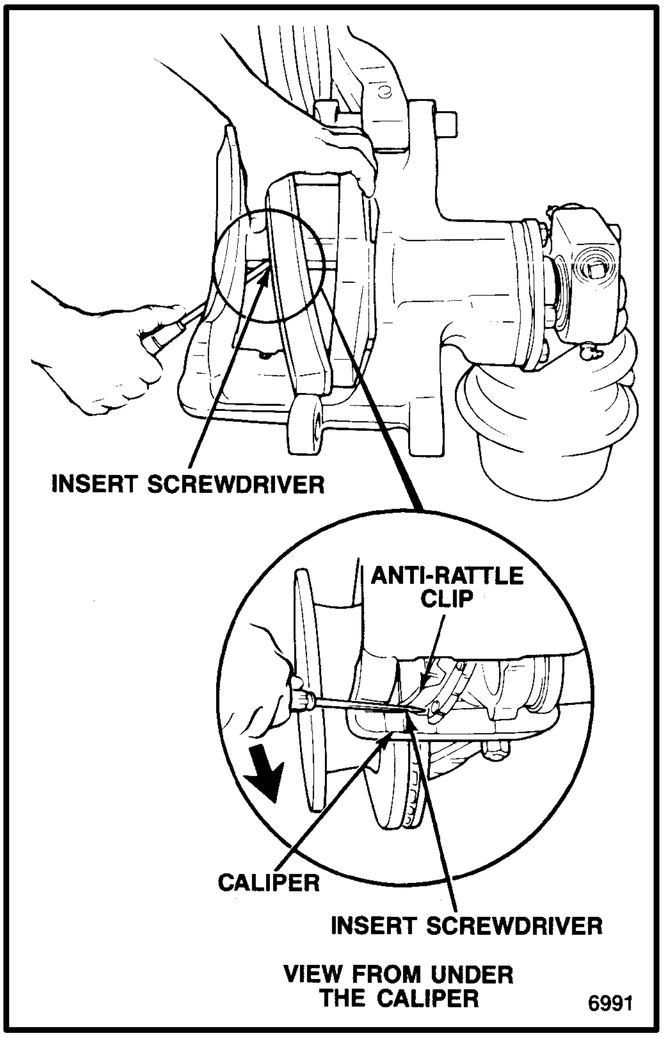


Figure 21. Pad Clip Insertion

4. Raise the caliper and align its bores with the torque plate (Figure 22).

5. Reinstall the slide pin and retainer and check for proper slide action of caliper when actuated.

6. Adjust the brakes per the “Adjustment” procedures found in the Slack Adjuster portion, and check for proper operation.

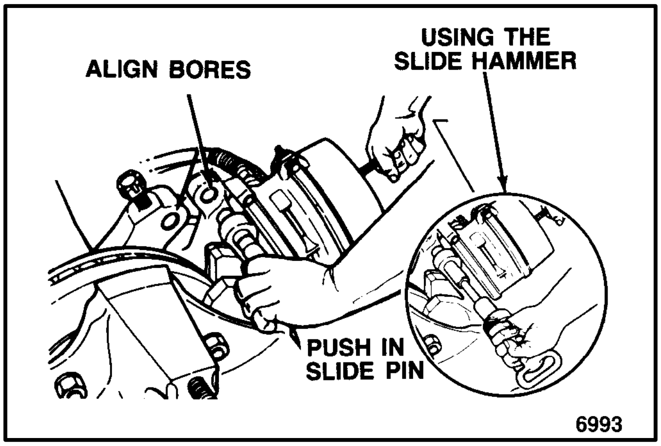


Figure 22. Slide Pin And Caliper Installation

CALIPER REMOVAL

1. Follow steps 1 thru 5 of the previous “Brake Linings Removal” procedure.

2. Bleed air pressure from the brake chambers and remove the air lines.

NOTE: If the top slide pin has been previously removed, temporarily reinstall into the torque plate to support the caliper.

⚠ WARNING ⚠

When removing clevis pins with helper spring, hold spring with pliers. The spring can disengage from the clevis and cause injury.

3. Remove both clevis pins from the slack adjuster.

4. Unfasten and remove the hex nuts that hold the air brake chamber to the bracket and remove chamber (Figure 23).

5. Remove the cotter pin from the lower side pin retainer, and loosen the nut on the retainer (Figure 24).

6. Press the end of the retainer to release the slide pin. Pull the slide pin out of the caliper and the torque plate.

NOTE: If the retainer cannot be pressed or remove the slide pin by hand, use the following procedures.

⚠ WARNING ⚠

Wear safe eye protection if the slide pins require hitting to loosen them. Do not hit these parts with a steel hammer. The steel parts can break and cause serious personal injury. Use a brass mallet.

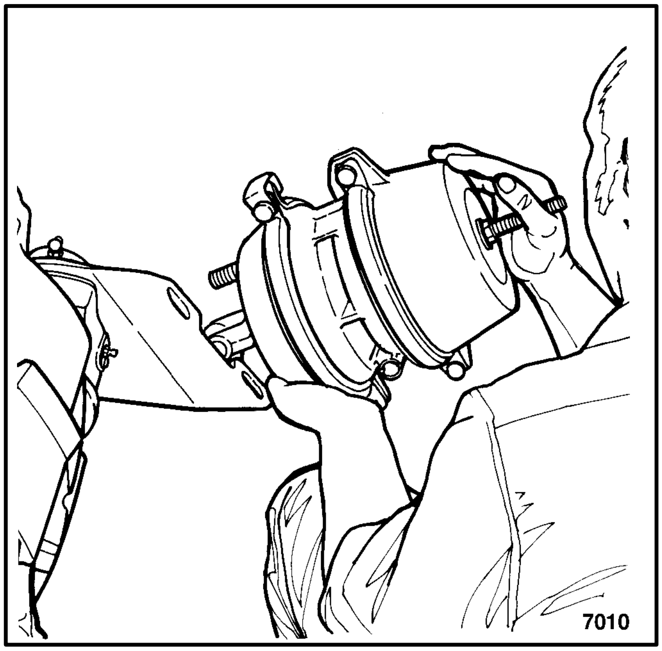


Figure 23. Brake Chamber Removal

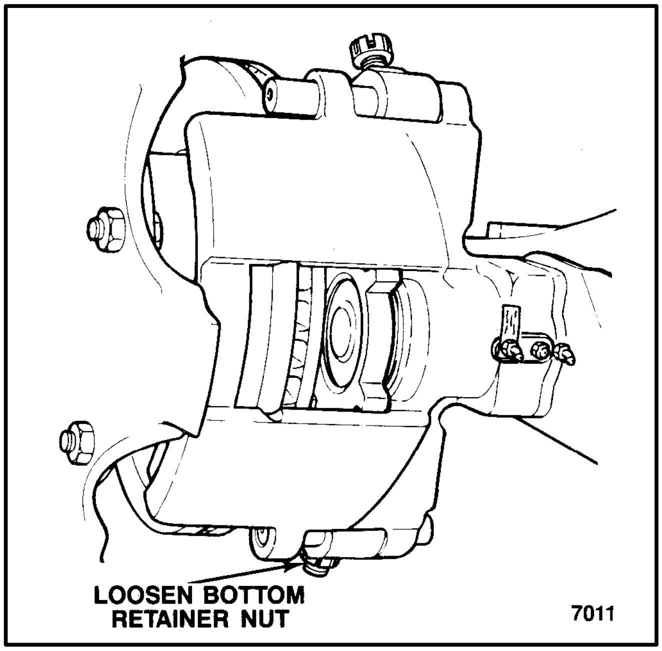


Figure 24. Bottom Retainer and Slide Pin

A. Apply penetrating oil to help loosen the retainer. Turn the nut until the end of the retainer is flush with the top of the nut. Hit the nut with a mallet to loosen the retainer.

B. Install a slide hammer in the threaded hole in the end of the slide pin. If necessary, install an extension bar to give clearance. Press the end of the retainer to release the slide pin while using the knocker to loosen and remove the pin.

7. Pull the bottom of the caliper away from the rotor and support the caliper (Figure 25).

8. Remove the top slide pin using the same steps, and lift the caliper away from the rotor.

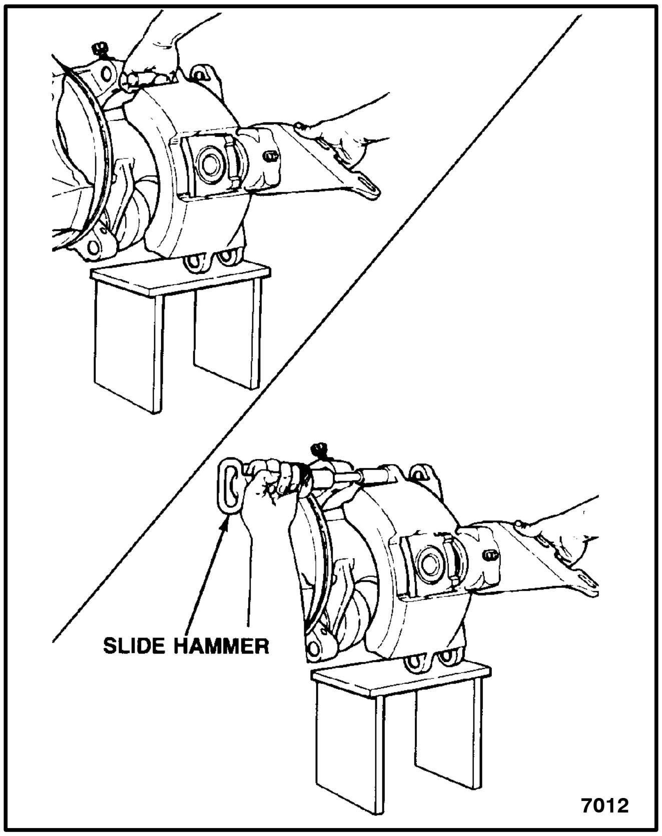


Figure 25. Installing Caliper Slide Pins

CALIPER DISASSEMBLY

NOTE: If disassembling more than one caliper at the same time, keep the components of each caliper separate. Install brake parts only on the same caliper from which they were removed.

NOTE: Procedures shows bench removal of the components, however, these procedures may be undertaken while caliper is still mounted to coach.

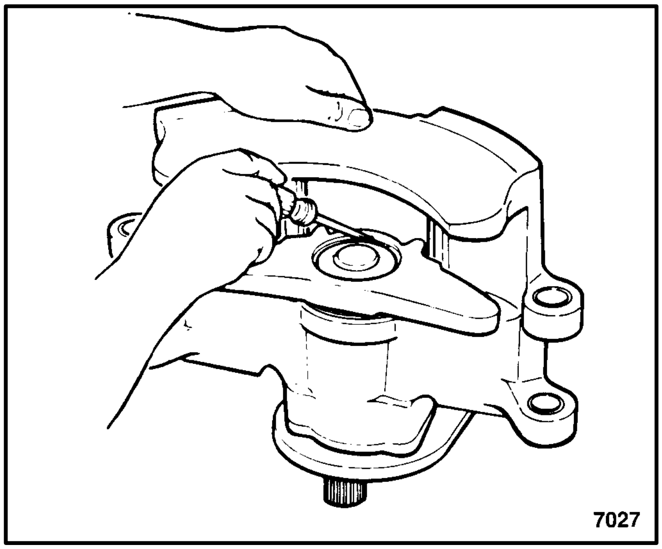


Figure 26. Removing Seal Snap Ring

Piston Removal

1. Use a tool with a point to remove the snap ring retaining the seal in the piston bore (Figure 26).

2. Remove the pressure relief valve from the caliper, and install an air fitting.

⚠ WARNING ⚠

Wear eye protection when removing the seal. Seal can dislodge suddenly and cause serious injury.

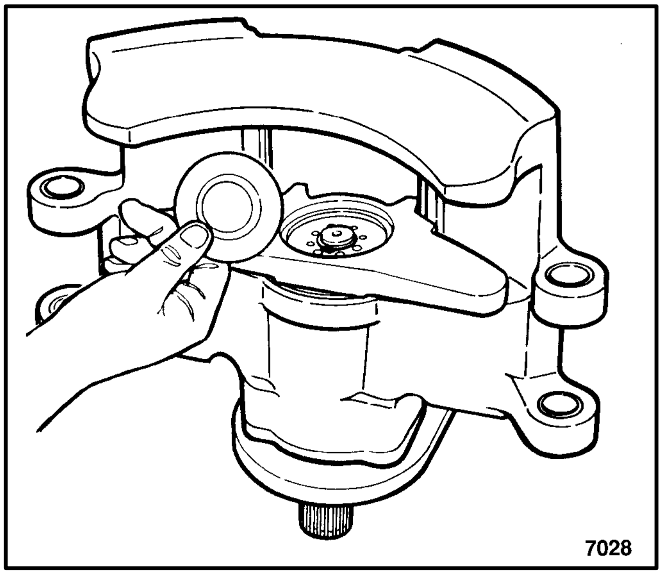


Figure 27. Removing The Piston Seal

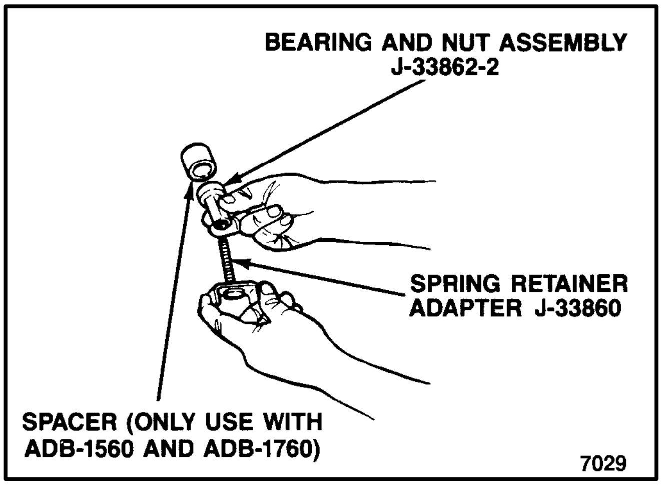


Figure 28. Spring Retainer Tool

3. After placing a rag over the piston seal to capture it after it dislodges, carefully apply air pressure to the fitting to force the seal form the caliper (Figure 27).

4. Reinstall the pressure relief valve into the caliper.

5. Assemble and use the special adapter tool to remove the piston spring retainer (Figure 28).

NOTE: If the rotor is vented, also install the spacer over the bearing.

WARNING

Wear eye protection when removing the piston spring retainer. Snap ring and spring retainer can dislodge suddenly and cause serious injury if adapter tool is not used.

6. Place the tool between the spring retainer and the caliper leg, and directly over the spring retainer (Figure 29).

7. Turn the nut and force it against the spacer or the caliper to release the return spring pressure on the snap ring (Figure 30).

8. Use 45 degree snap ring pliers to remove the snap ring (Figure 33).

9. Turn the nut in the opposite direction to release the spring pressure. When the tool is completely retracted, hold the spring retainer with one hand and remove the tool (Figure 34).

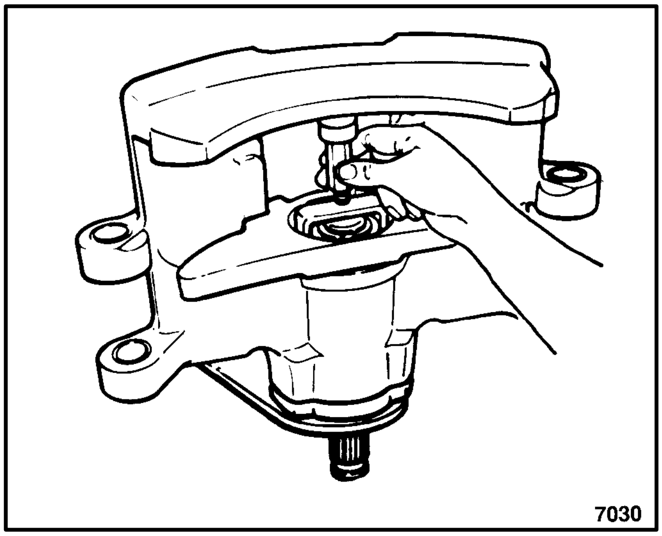


Figure 29. Spring Retainer Tool Installed

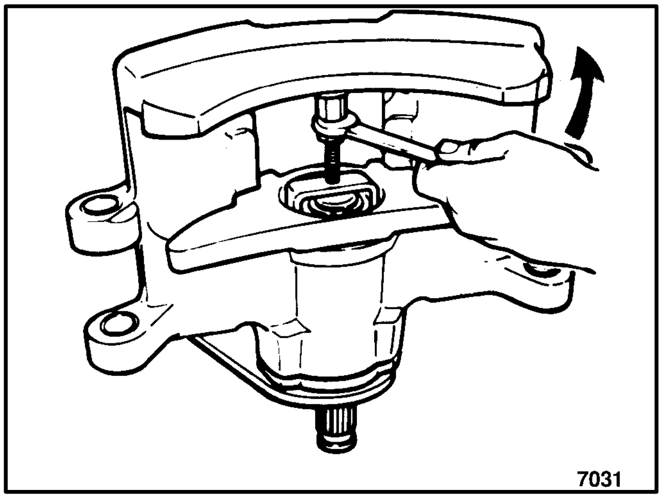


Figure 30. Releasing Return Spring

10. Remove the spring retainer and the return spring (Figure 35).

11. Remove the piston from the caliper (Figure 36).

NOTE: If equipped with piston to caliper boot assembly, remove the lip of the boot from the groove in the piston. The boot will remain in the bore of the caliper until removed.

12. Using a tool with a thin blade, remove the boot from the caliper (Figure 37).

NOTE: Do not damage the caliper bore while removing the boot or O-ring.

13. Using a tool with a thin blade, remove the O-ring from the bore of the caliper (Figure 31).

NOTE: If only the replacement of the boot and O-ring is to be performed, make the following inspections, install the new components and reassemble the caliper per the applicable assembly procedures that follow.

A. Clean and inspect the outside of the piston for scratches or other damage.

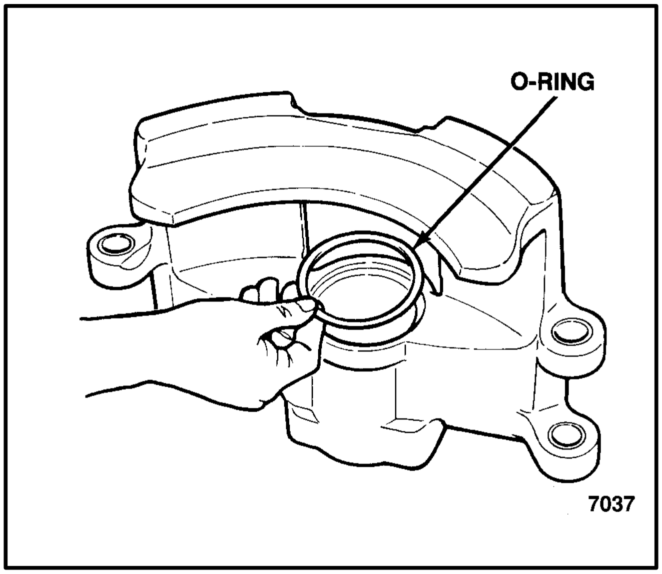


Figure 31. Piston O-ring Removal

NOTE: Refer to the “Parts Cleaning and Inspection” guide lines at the end of the brake assembly section. A light polishing of the piston is normal, however, if the piston is damaged, discard it and completely overhaul the caliper.

B. Use a clean cloth to clean the O-ring groove in the bore. Do not use solvent to clean the O-ring groove.

NOTE: Solvent residue may damage O-ring seal or cause lubricant to deteriorate.

C. Inspect the lubricant in the bore for dirt, water or any other contamination.

NOTE: If the lubricant is contaminated, the caliper should be completely overhauled.

Powershaft & Cap Removal

1. Unfasten and remove the powershaft cap and the brake chamber bracket capscrews and remove the bracket (Figure 32).

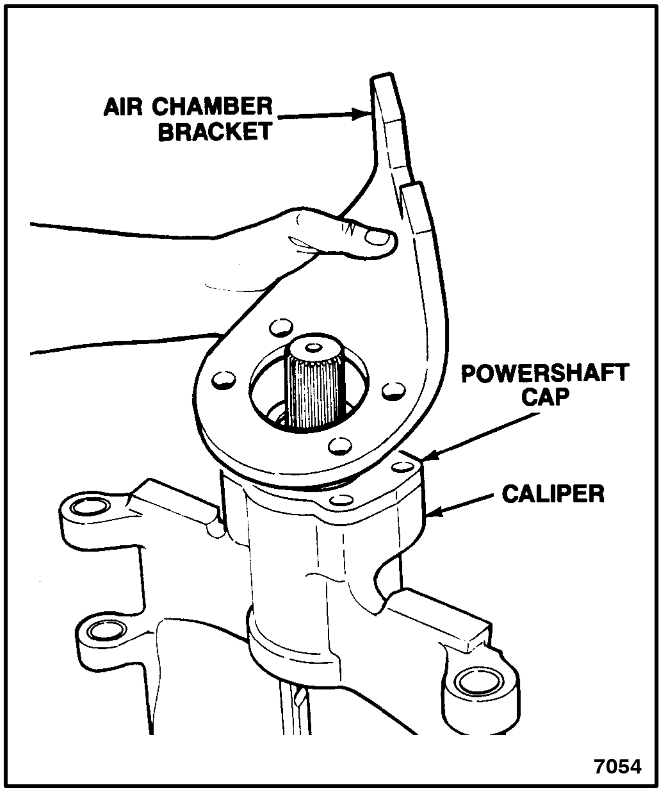


Figure 32. Brake Chamber Bracket Removal

2. Lift the powershaft, cap and actuator nut assembly out of the caliper (Figure 38). o not turn the shaft or the actuator nut will fall from the end of the shaft.
3. Use snap ring pliers to remove the snap ring from the power shaft (Figure 39).
4. Remove the dust cover from the powershaft (Figure 40).
5. Separate the cap from the power shaft and remove the powershaft actuator nut and thrust washer (Figure 41).

NOTE: Discard the thrust washer and use a new thrust washer when reassembling the caliper.

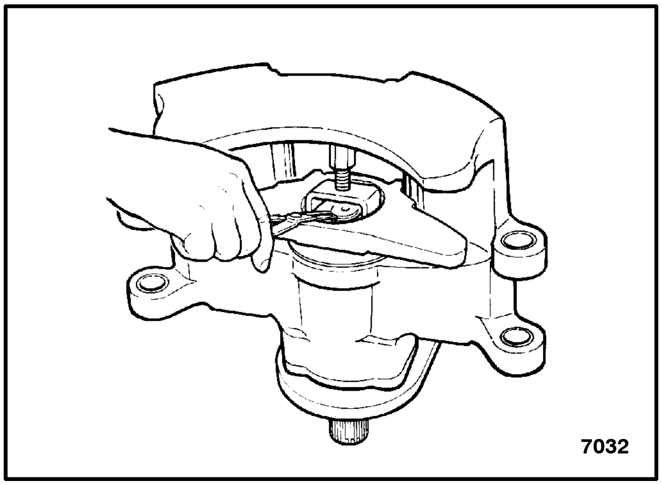


Figure 33. Snap Ring Removal

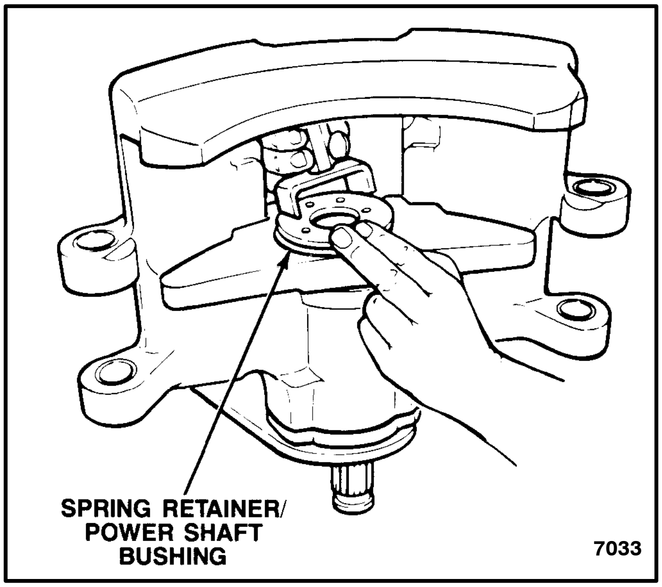

SPRING RETAINER/
POWER SHAFT
BUSHING
7033

Figure 34. Removing Spring Retainer Tool

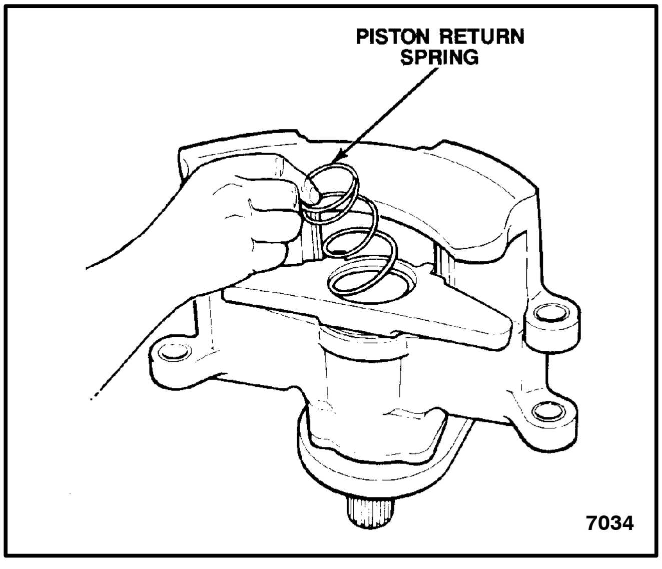

PISTON RETURN
SPRING
7034

Figure 35. Piston Return Spring Removal

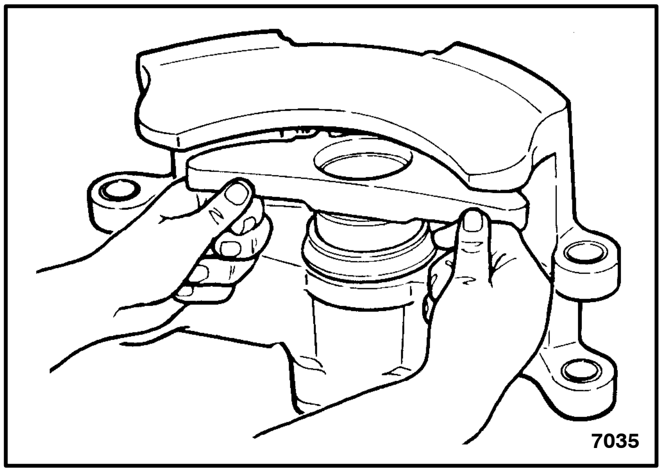


Figure 36. Piston Removal

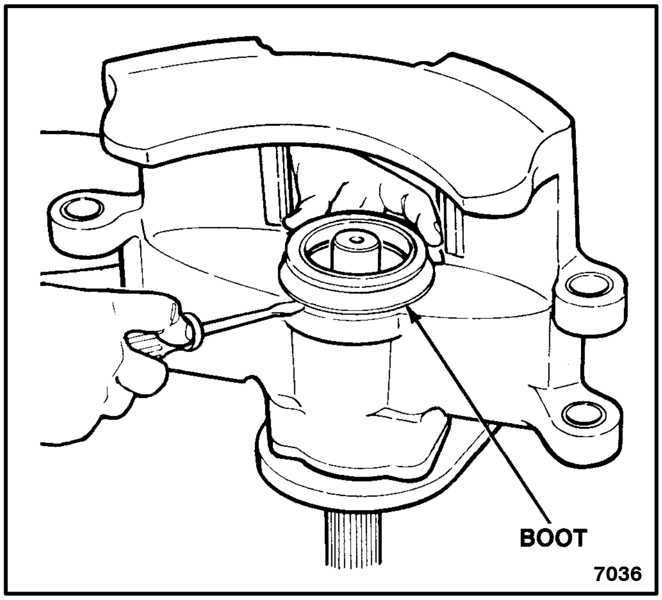


Figure 37. Piston Boot Removal

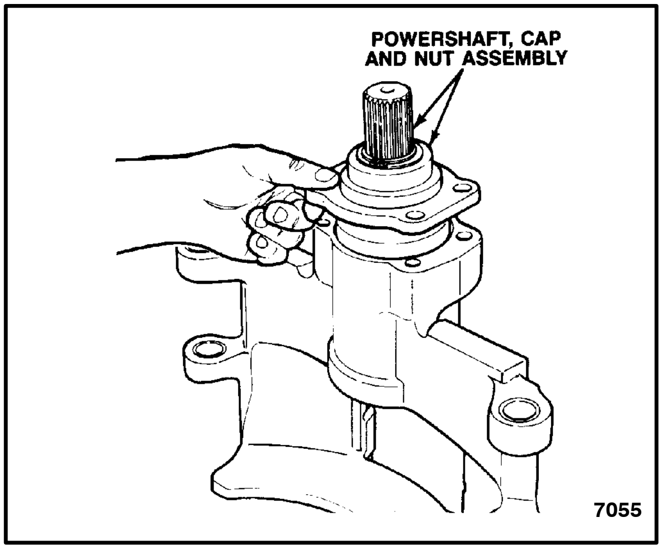

POWERSHAFT, CAP
AND NUT ASSEMBLY
7055

Figure 38. Powershaft Cap Removal

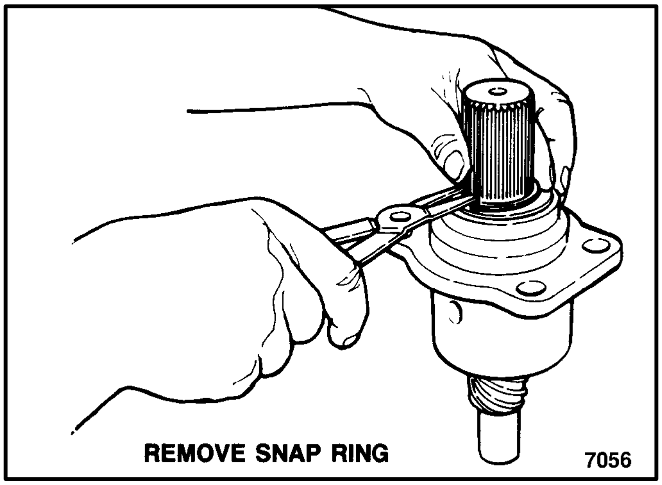

REMOVE SNAP RING
7056

Figure 39. Powershaft Snap Ring Removal

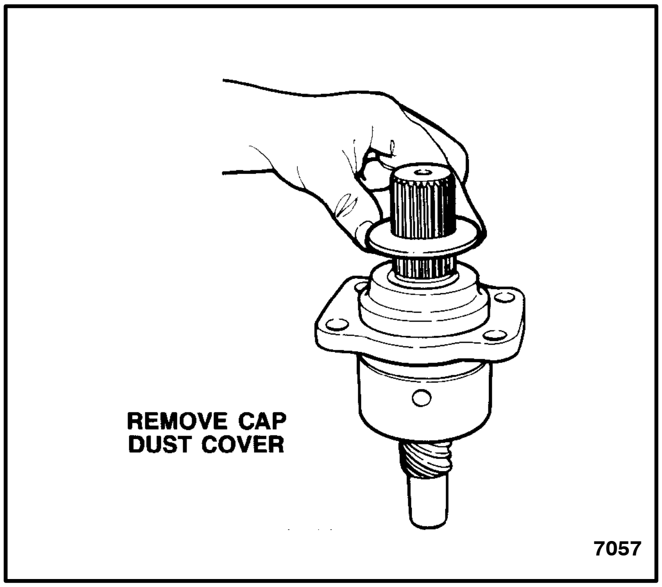

REMOVE CAP
DUST COVER
7057

Figure 40. Powershaft Dust Cover Removal

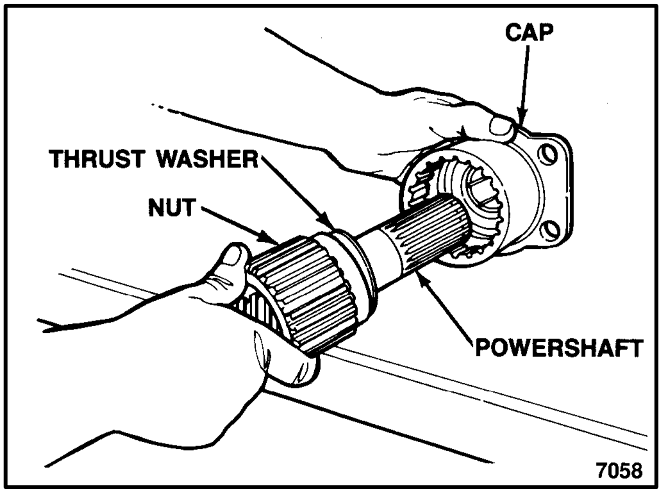

CAP
THRUST WASHER
NUT
POWERSHAFT
7058

Figure 41. Powershaft Cap Removal

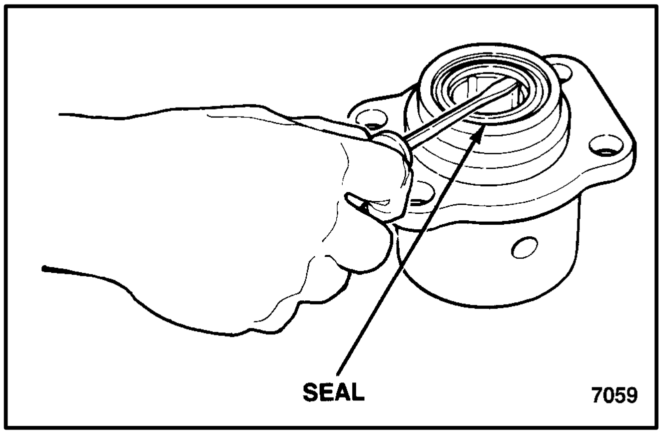


Figure 42. Powershaft Cap Seal Removal

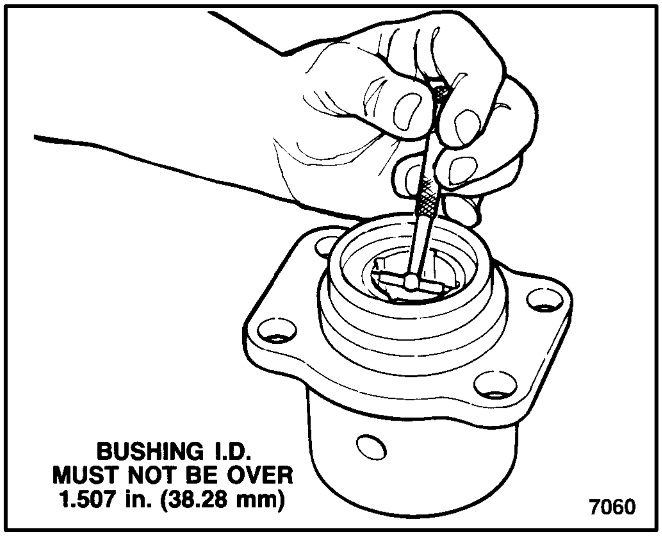

BUSHING I.D.
MUST NOT BE OVER
1.507 in. (38.28 mm)
7060

Figure 43. Powershaft Cap Bushing Check

6. Remove the O-ring from the groove in the outer diameter of the powershaft cap.

7. Use a tool with a flat blade to remove the seal from the bore in the powershaft cap (Figure 42).

NOTE: Do not damage the bushing inside the cap.

8. Measure the inner diameter of the bushing in the powershaft cap (Figure 43).

NOTE: The inner diameter must not exceed 1.507 inches (38.28 mm). Discard the powershaft cap and bushing assembly if inner diameter is too large. Use a new assembly when reassembling the caliper.

NOTE: Measure both bushings on models with the extended powershaft caps and bushings at each end.

CALIPER BUSHING INSPECTION

Use a pin gauge (P/N J-34064-54) to check for bushing wear while caliper is mounted on coach (Figure 44). Use the plug gauge (P/N J-34064-53) to check for bushing wear with caliper removed (Figure 45).

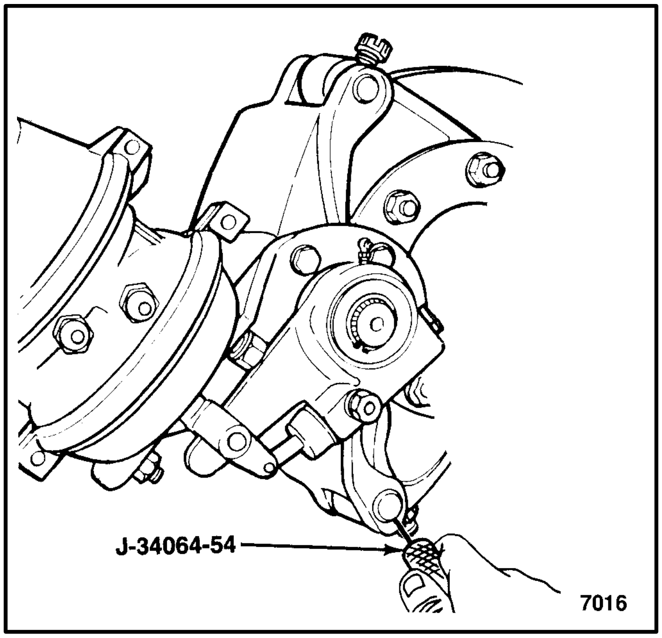


Figure 44. Checking Bushing W/Pin Gauge

CAUTION

If any caliper bushing is worn, replace all four caliper bushings. If new bushings are mixed with worn bushings, alignment problems will occur.

NOTE: If the pin gauge will fit between the slide pin and the bushing or plug gauge fits into the bushing, the slide pin and/or bushing are worn and should be replaced.

To check the bushings without a plug gauge, measure the inner diameter of all four caliper bushings at three locations (Figure 46).

NOTE: Replace the bushings if the diameter of any bushing exceeds 1.052 inches (26.72 mm).

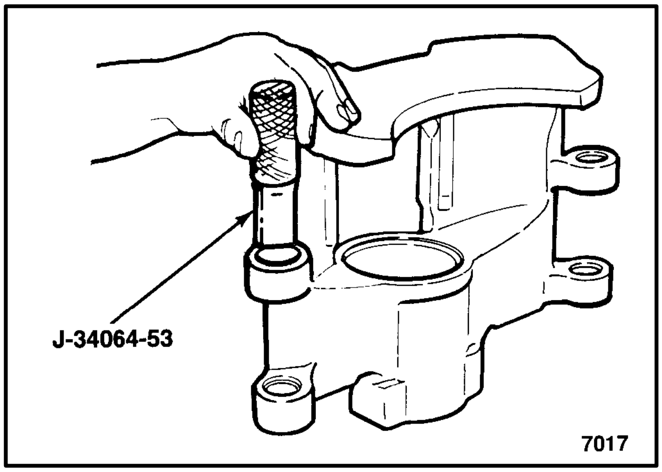


Figure 45. Checking Bushings W/Plug Gauge

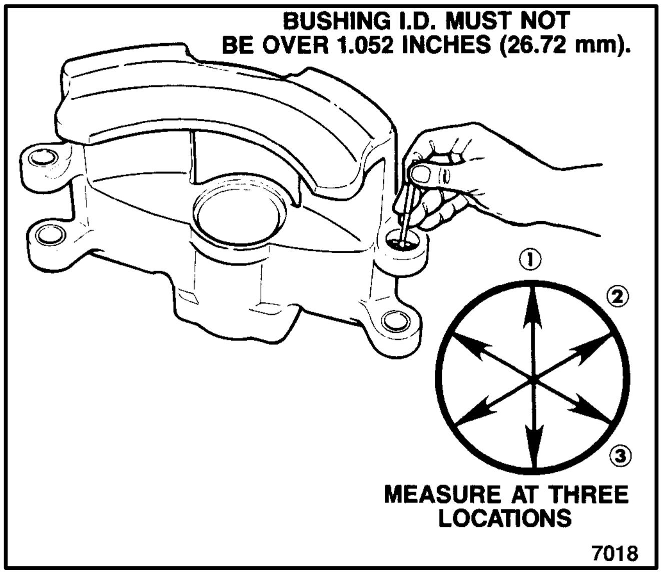

BUSHING I.D. MUST NOT BE OVER 1.052 INCHES (26.72 mm).
①
②
③
MEASURE AT THREE LOCATIONS
7018

Figure 46. Checking Bushings (No Gauge)

CAUTION

If a bushing has worn completely through, remove the bushing and inspect the caliper bore for bore wear using the “Bore Inspection” procedures that follow.

BUSHING REMOVAL

WARNING

Wear safe eye protection when driving bushings. Do not hit these parts with a steel

hammer. The steel parts can break and cause serious personal injury. Use a brass mallet.

⚠ CAUTION ⚠

Support the caliper boss when removing the bushings. The force used to drive a bushing can break the boss if it is not supported.

1. Remove the caliper from the coach.

2. Use a bushing driver and a press or a mallet to remove the bushings (Figure 47).

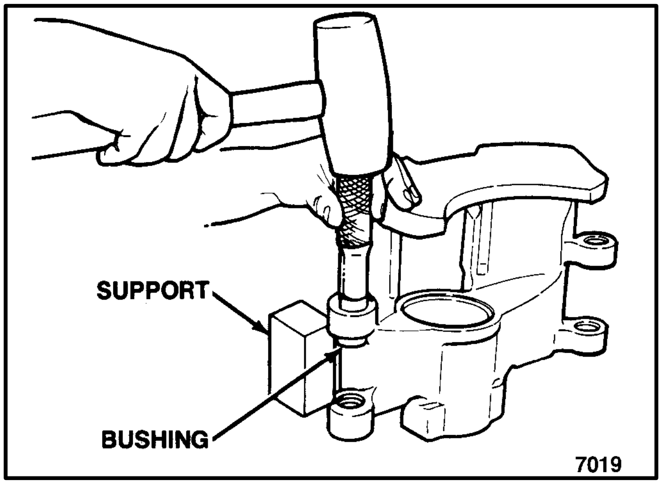

SUPPORT
BUSHING
7019

Figure 47. Removing Bushing

CALIPER BORE INSPECTION

1. Clean and inspect the bore for wear or other damage.

NOTE: Refer to the “Parts Cleaning and Inspection” guide lines at the end of the brake assembly section.

2. Measure the diameter of the bore at three locations (Figure 48).

NOTE: The diameter must be within limits of 1.118-1.120 inches (28.397-28.448 mm). If any of the bores exceed 1.120 inches (28.448 mm) the caliper must be replaced.

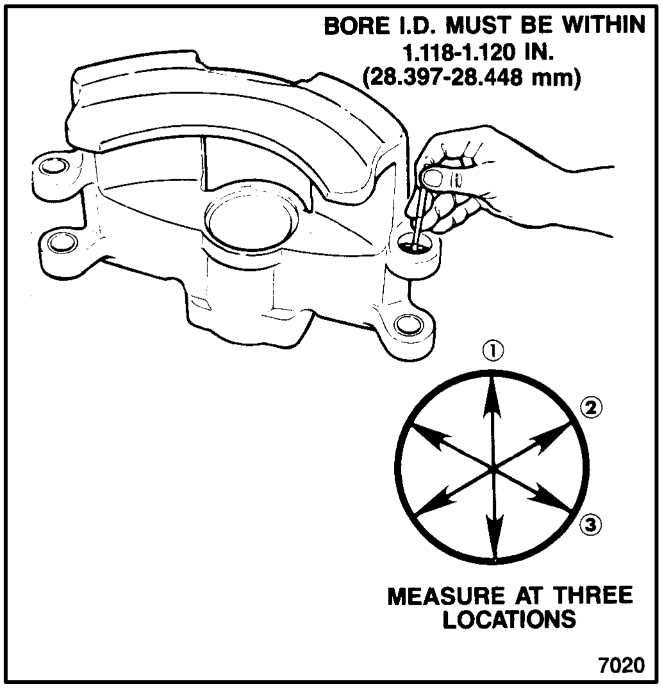

BORE I.D. MUST BE WITHIN
1.118-1.120 IN.
(28.397-28.448 mm)
①
②
③
MEASURE AT THREE
LOCATIONS
7020

Figure 48. Measuring Caliper Bores

BUSHING INSTALLATION

NOTE: New bushings must be installed in sets. Do not use old and new bushings in the same caliper. The bushing repair kits consist of four (4) bushings.

1. Make sure the caliper bores are clean and any rough edges of bores are deburred.

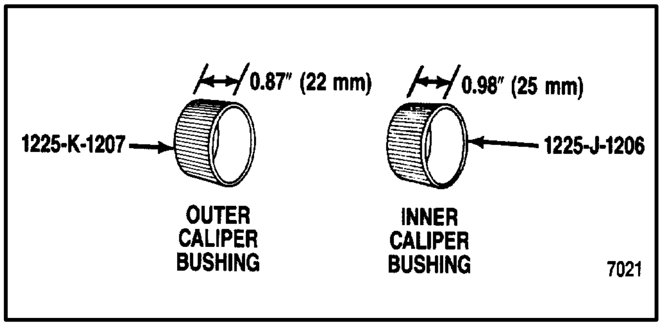

0.87" (22 mm)
0.98" (25 mm)
1225-K-1207
1225-J-1206
OUTER
CALIPER
BUSHING
INNER
CALIPER
BUSHING
7021

Figure 49. Caliper Bushings

NOTE: Bushings have locking serrations on the outside diameter (Figure 49). These bushings should not need to be burnished (sized) after they are installed.

2. Clean and inspect the bushing drivers to be used for any damage or out of size condition (Figure 50).

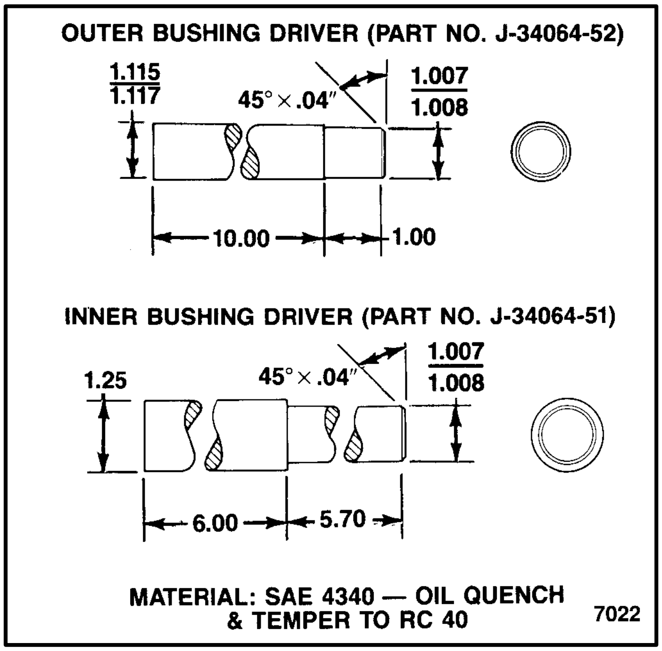

OUTER BUSHING DRIVER (PART NO. J-34064-52)
1.115
1.117
45° × .04″
1.007
1.008
10.00
1.00
INNER BUSHING DRIVER (PART NO. J-34064-51)
1.25
45° × .04″
1.007
1.008
6.00
5.70
MATERIAL: SAE 4340 — OIL QUENCH & TEMPER TO RC 40
7022

Figure 50. Bushing Drivers

NOTE: Special bushing drivers are used to assure that bushings are correctly aligned when installed (Figure 50). The drivers can be made from the information found herein or purchased from Kent-Moore.

3. Measure the length of the inner and outer bosses to assure that the correct bushing will be installed in each boss (Figure 51).

NOTE: The length of the inner boss is approximately 1.0 inch (25.4 mm). The length of the outer boss is approximately 0.87 inch (22 mm).

⚠ CAUTION ⚠

When installing the bushings, support the caliper bosses. The force used to drive a bushing can break a boss, if the boss is not supported.

4. Install the outer bushings first using a mallet or press and the outer bushing driver (Figure 52).

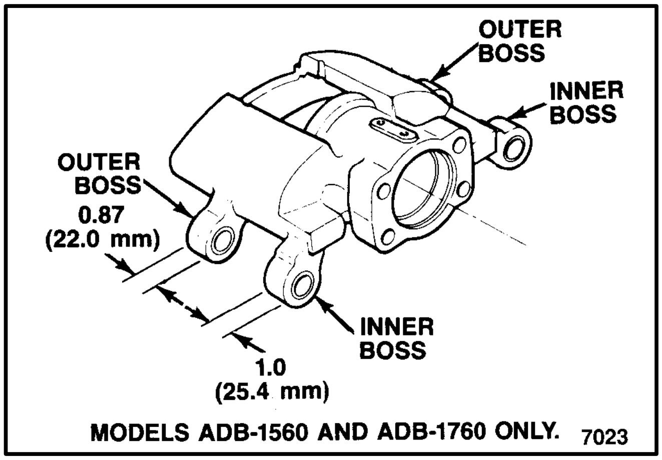

OUTER BOSS
INNER BOSS
OUTER BOSS
0.87
(22.0 mm)
INNER BOSS
1.0
(25.4 mm)
MODELS ADB-1560 AND ADB-1760 ONLY.
7023

Figure 51. Caliper Boss Sizes

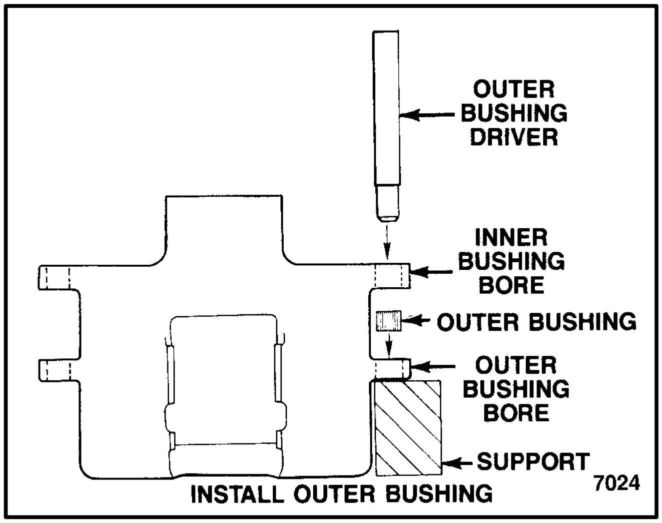

OUTER BUSHING DRIVER
INNER BUSHING BORE
OUTER BUSHING
OUTER BUSHING BORE
SUPPORT
INSTALL OUTER BUSHING
7024

Figure 52. Outer Bushing Installation

A. Set the caliper on a bench with the inner bushing bore on top.

B. Using the inner bushing bore for tool alignment, insert the the outer bushing driver through the inner bushing bore and into the outer bushing.

C. Place bushing and carefully tap or press the driver until the outer bushing is in the center of its bore.

NOTE: The bushing must not extend past either side of the caliper boss.

5. Install the inner bushings (Figure 53). Use a mallet or press and the inner bushing driver.

A. Place the inner bushing on the driver. Using the installed outer bushings for tool alignment, put the small diameter end of the inner bushing driver through the inner bushing bore and insert into the installed outer bushing.

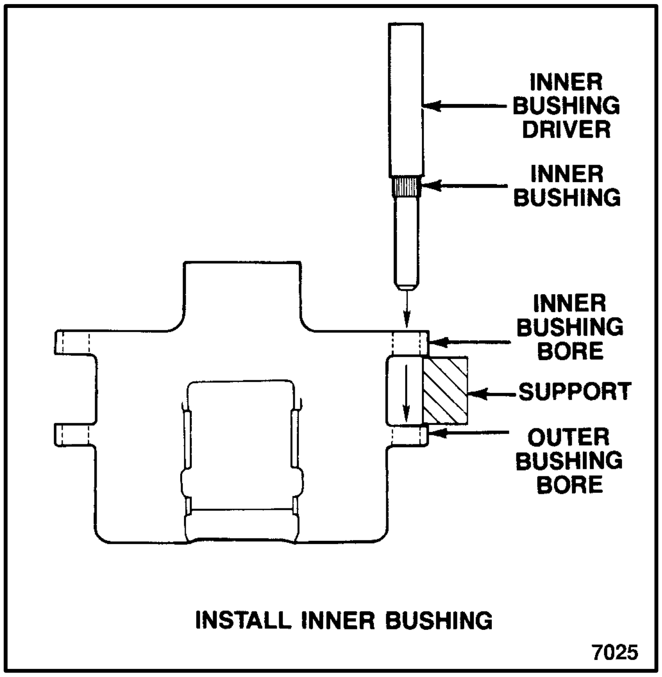

INNER BUSHING DRIVER
INNER BUSHING
INNER BUSHING BORE
SUPPORT
OUTER BUSHING BORE
INSTALL INNER BUSHING
7025

Figure 53. Inner Bushing Installation

B. Carefully tap or press the driver until the inner bushing is in the center of its bore. The bushing must not extend past either side of the caliper boss.

6. Measure the inner diameter of the installed bushings (Figure 54).

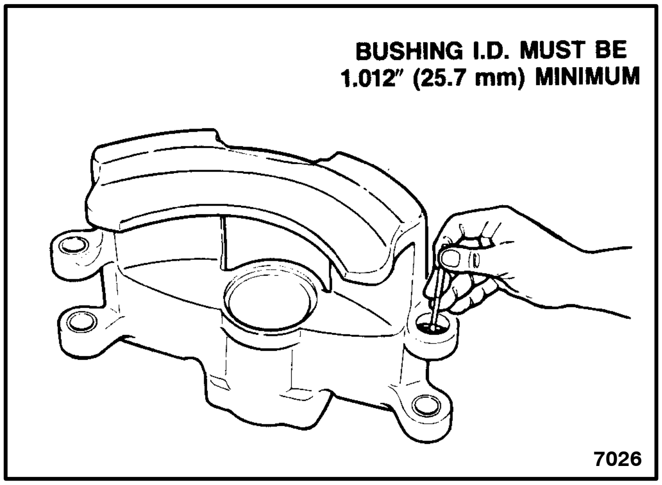

BUSHING I.D. MUST BE 1.012″ (25.7 mm) MINIMUM
7026

Figure 54. Checking Bushing Diameter

NOTE: If the diameter is not 1.012 inches (25.7 mm), the bushings must be reamed to the correct diameter. A suitable reamer (P/N J-38388) is available from Kent-Moore. If the diameter exceeds 1.012 inches (25.7 mm), install a new bushing.

CALIPER ASSEMBLY

NOTE: Always discard the old seals, boots and O-rings, and use only new components when assembling the caliper.

Powershaft & Cap Assembly

1. Place a new seal over the bore of the powershaft cap's flanged end (Figure 55).

2. Install the seal using a press and a steel pressing plate.

NOTE: Seal is correctly installed when seal lip is facing away from the powershaft cap, and even with the end of the bore.

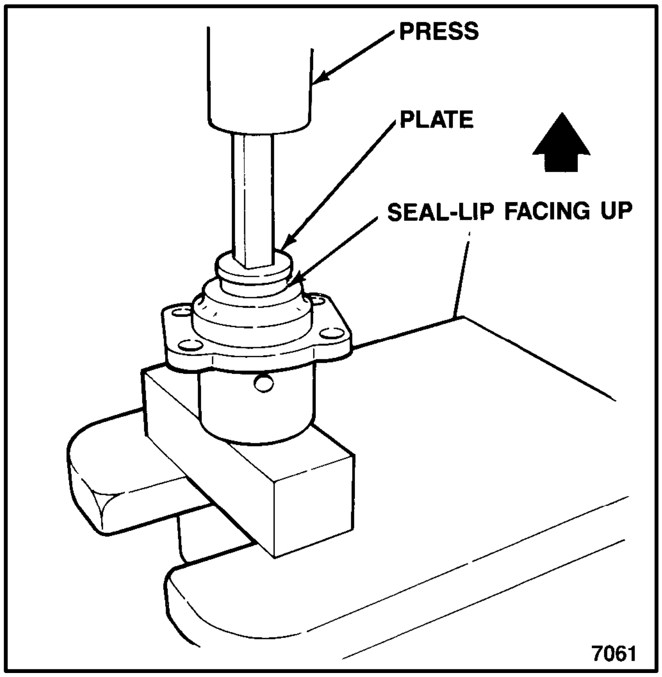

PRESS
PLATE
SEAL-LIP FACING UP
7061

Figure 55. Powershaft Cap Seal Installation

3. Install a new O-ring in the groove on the outer diameter of the powershaft cap.

4. Apply grease liberally to the threads of the powershaft, splines of the powershaft actuator nut, surfaces of the thrust washer and bushing and splines inside the powershaft cap.

5. Install the actuator nut onto the threads of the powershaft (Figure 56).

6. Install the thrust washer with its lip toward the splines.

7. Install the powershaft and actuator nut assembly into the powershaft cap.

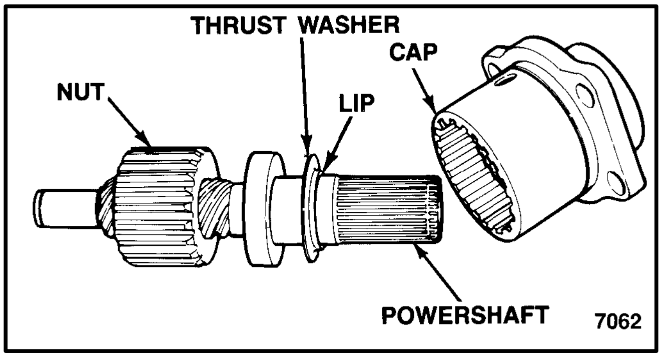

THRUST WASHER
CAP
NUT
LIP
POWERSHAFT
7062

Figure 56. Powershaft Assembly

8. Place the powershaft dust cap onto the shaft, and install the snap ring retainer onto the powershaft (Figure 57).

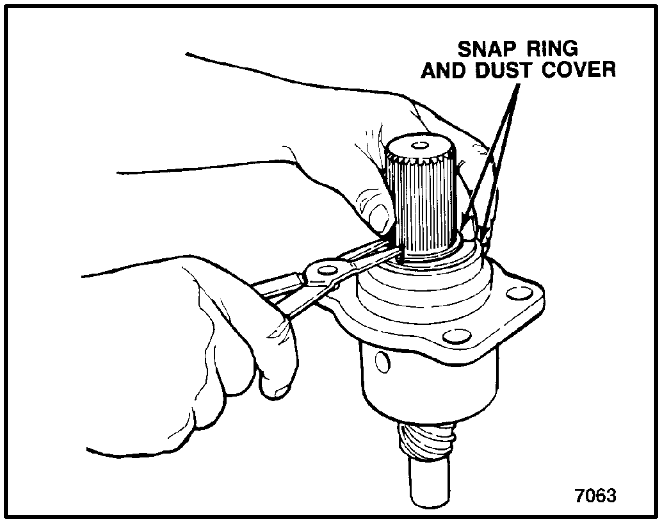

SNAP RING
AND DUST COVER
7063

Figure 57. Install Powershaft Snap Ring

9. Put the powershaft, actuator nut and cap assembly into the caliper (Figure 58). Install the grease fitting in the cap's outboard hole so it can be reached for service and install the bracket.

10. Place the brake chamber mounting bracket over the cap, install the capscrews and torque to 135-170 ft-lbs (183-230 N·m) (Figure 59).

Piston Assembly

1. Install the new O-ring into the caliper bore (Figure 60).

2. Assemble the boot installation adapter tool used to install the boot (Figure 61).

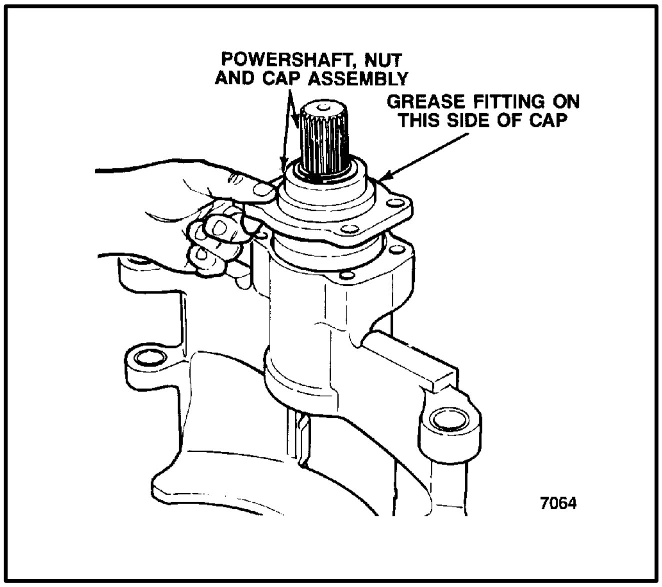

POWERSHAFT, NUT
AND CAP ASSEMBLY
GREASE FITTING ON
THIS SIDE OF CAP
7064

Figure 58. Installing Powershaft and Cap

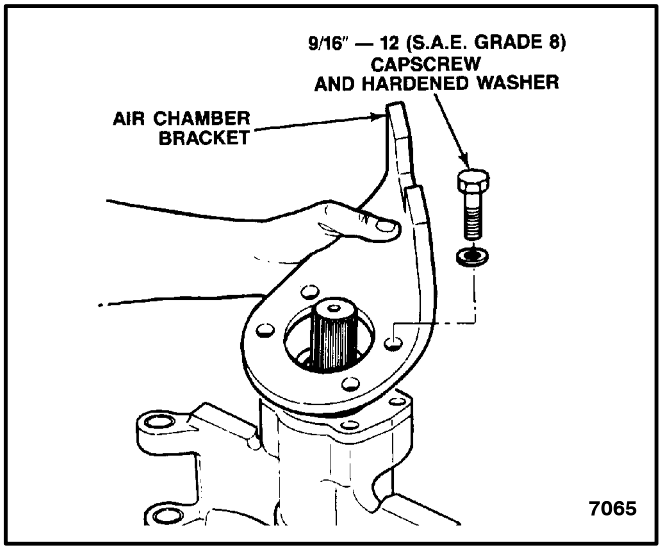

9/16" — 12 (S.A.E. GRADE 8)
CAPSCREW
AND HARDENED WASHER
AIR CHAMBER
BRACKET
7065

Figure 59. Mount Brake Chamber Bracket

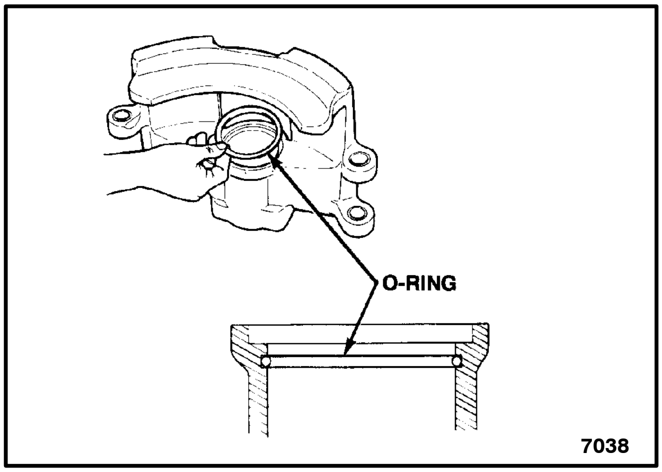


Figure 60. O-ring Installation

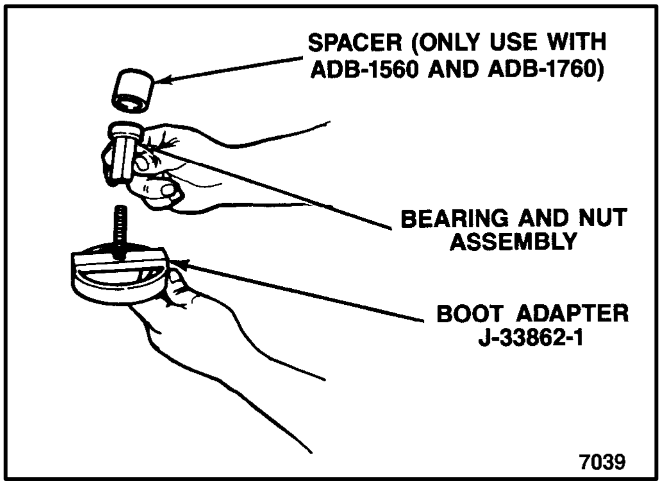

SPACER (ONLY USE WITH ADB-1560 AND ADB-1760)
BEARING AND NUT ASSEMBLY
BOOT ADAPTER J-33862-1
7039

Figure 61. Boot Installation Adapter

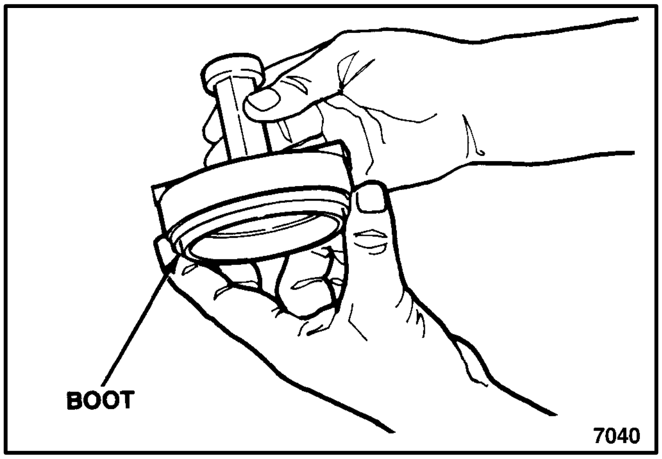


Figure 62. Boot In Adapter

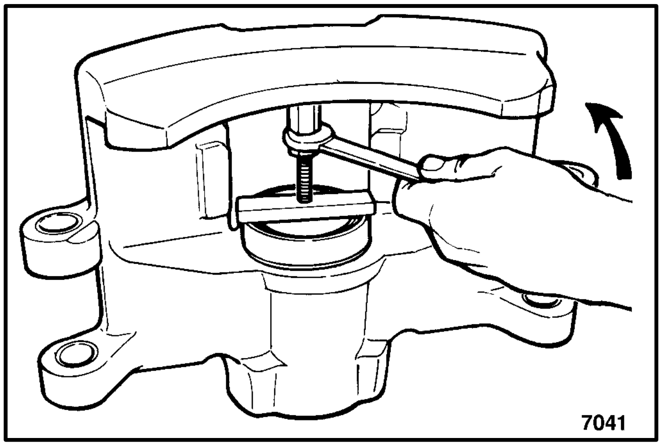


Figure 63. Piston Boot Installation

3. Place the boot straight into the adapter. The boot seat must face away from the adapter (Figure 62).

NOTE: If the rotor is vented, also install the spacer over the bearing.

4. Place the tool with boot between the caliper leg and directly over the bore. Carefully turn the nut until the boot is installed in the bore (Figure 63).

⚠ CAUTION ⚠

The boot could be damaged during installation, if not set directly over the bore. Boot is correctly installed when the boot seat touches the caliper. Do not over-extend the seating tool or the boot may be damaged.

5. Turn the nut in the opposite direction to retract and remove the tool.

6. Apply grease to the outer diameter of the piston and carefully install the piston through the boot and into the caliper (Figure 64).

7. Slide the boot over the piston while pushing the piston into the bore. Make sure boot lip is fitted into the groove of the piston.

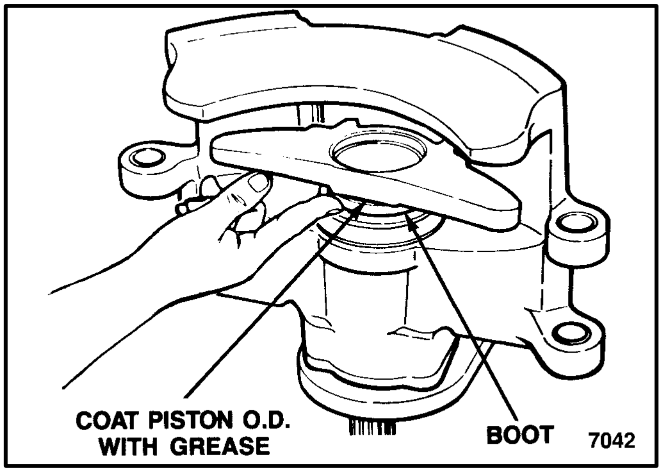

COAT PISTON O.D. WITH GREASE
BOOT
7042

Figure 64. Piston Installation

NOTE: If the powershaft capscrews were loosened, re-torque them to 135-170 ft-lbs (183-230 N·m).

8. Place the piston return spring into the piston large end first (Figure 65).

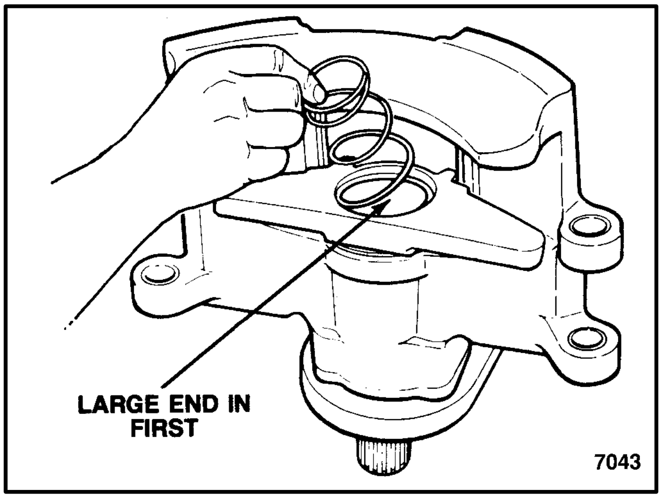

LARGE END IN FIRST
7043

Figure 65. Piston Return Spring Installation

9. Assemble the spring retainer bushing adapter tool (Figure 66).

NOTE: If the rotor is vented, also install the spacer over the bearing.

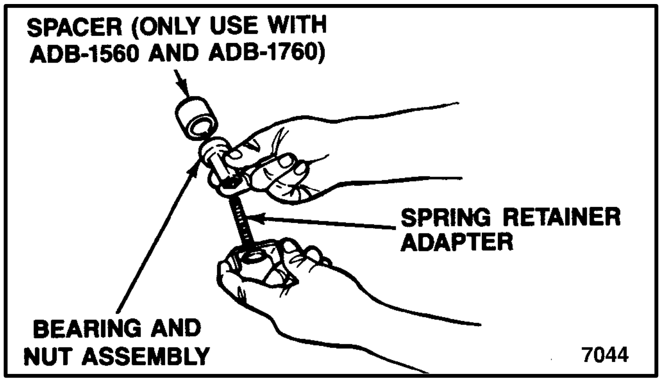

SPACER (ONLY USE WITH ADB-1560 AND ADB-1760)
SPRING RETAINER ADAPTER
BEARING AND NUT ASSEMBLY
7044

Figure 66. Retainer Adapter Tool

10. While holding the spring retainer bushing over the return spring, place the tool between the caliper leg and directly over the retainer bushing (Figure 67).

WARNING

Wear eye protection when removing the piston spring retainer bushing. Snap ring and spring retainer bushing can dislodge suddenly and cause serious injury.

11. Turn the nut and compress the spring and retainer bushing assembly below the snap ring groove in the powershaft (Figure 68).

12. Install the snap ring, using the 45 degree snap ring pliers (Figure 69).

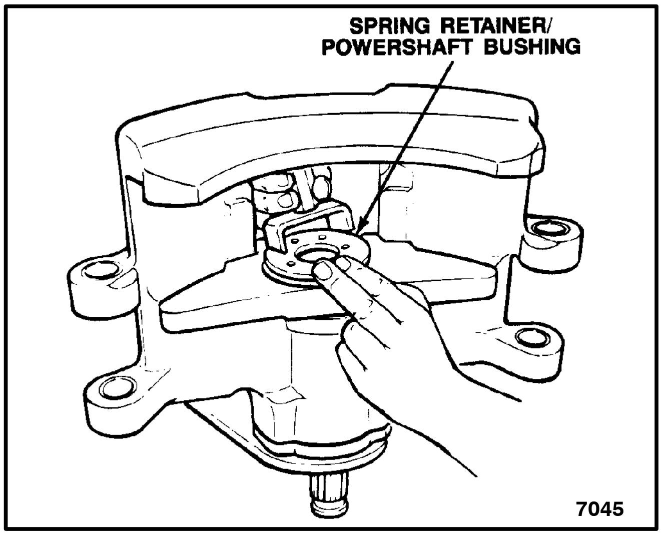

SPRING RETAINER/ POWERSHAFT BUSHING
7045

Figure 67. Installing Spring Retainer Bushing

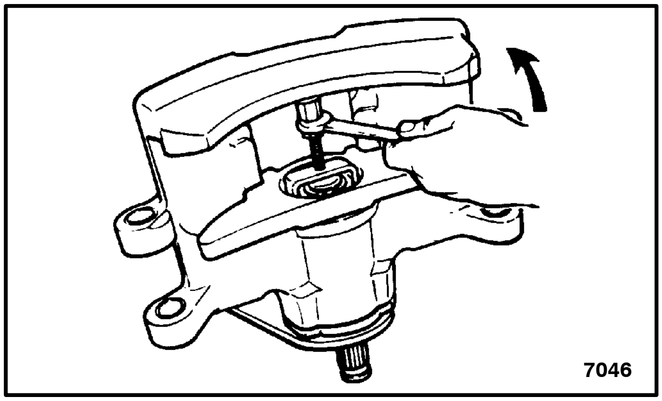


Figure 68. Compressing Spring & Retainer

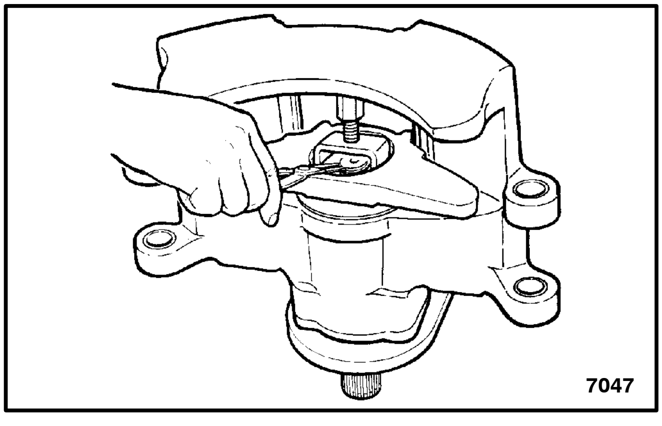


Figure 69. Installing Retainer Snap Ring

13. Turn the nut in the opposite direction to retract and remove the tool.

14. Place the seal into the piston bore and install the snap ring to hold the seal in place (Figure 70).

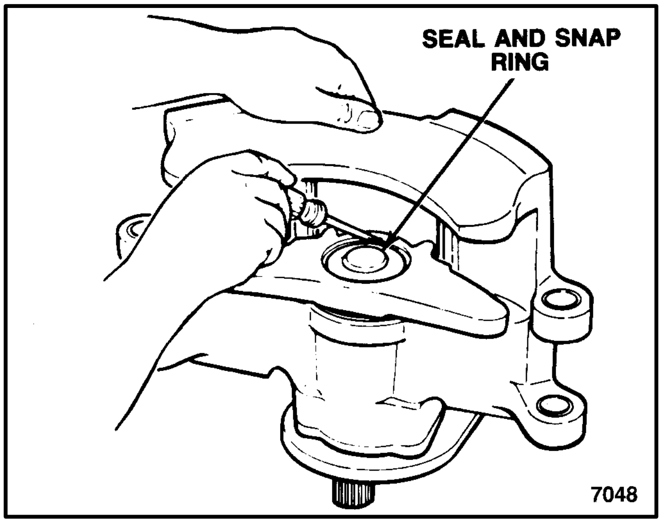

SEAL AND SNAP RING
7048

Figure 70. Installing Seal and Snap Ring

CALIPER INSTALLATION

NOTE: Refer to the “Parts Cleaning and Inspection” guide lines at the end of the brake assembly section.

1. Inspect the slides pins and retainers for any hardened grease, paint or other foreign materials, and that they are clean and undamaged.

2. Apply anti-seize compound to the slide pin retainer and install.

NOTE: Do not apply anti-seize compound to the threads on the slide pin retainer nor to the slide pin itself.

3. Install slide pin retainer assembly into it’s bore. The notches in the retainer and the slide pin must engage to properly secure the slide pin (Figure 71).

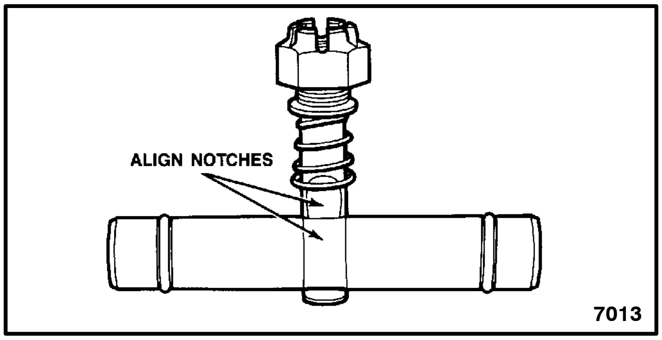

ALIGN NOTCHES
7013

Figure 71. Retainer and Slide Pin

4. Push down on the retainer assembly while pushing in on the slide pin (Figure 72). The retainer spring will cause the retainer to snap in place when the notches fully engage.

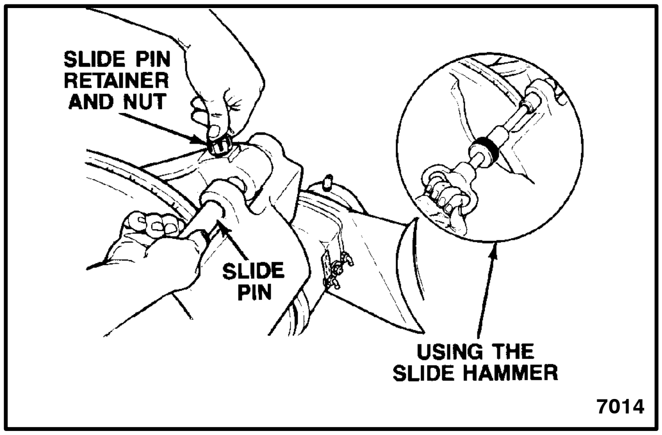

SLIDE PIN RETAINER AND NUT
SLIDE PIN
USING THE SLIDE HAMMER
7014

Figure 72. Installing Slide Pin

5. Install the top slide pin from the outboard side, while supporting the caliper and aligning its bores with the torque plate.

NOTE: Install the pin so that its threaded hole is toward the outboard side for future use of puller.

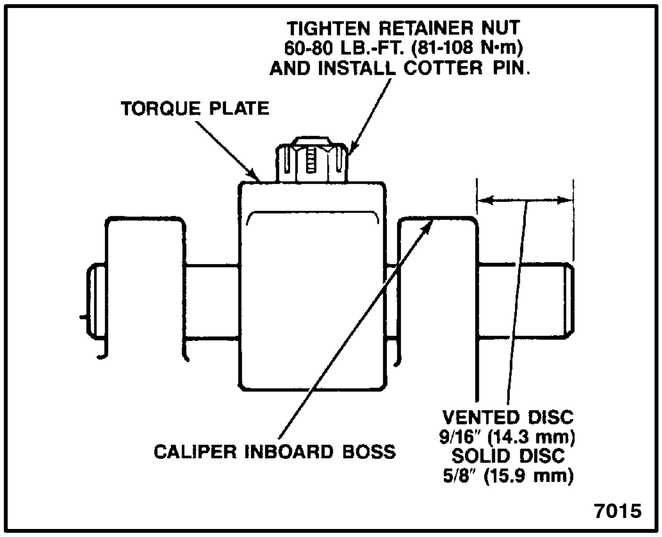

TIGHTEN RETAINER NUT 60-80 LB.-FT. (81-108 N·m) AND INSTALL COTTER PIN.
TORQUE PLATE
CALIPER INBOARD BOSS
VENTED DISC 9/16" (14.3 mm)
SOLID DISC 5/8" (15.9 mm)
7015

Figure 73. Slide Pin Installed

6. Make sure the pin extends past the inboard boss of the caliper (Figure 73).

NOTE: If the pin does not extend as shown in Figure 73, the pin is not installed correctly.

7. Torque the nut on the slide pin retainer to 60 ft-lbs (81 N·m). Then, tighten the nut to the next slot and install a new cotter pin through the nut and retainer.

NOTE: Do not exceed a torque of 80 ft-lbs (108 N·m).

8. Repeat this procedure to install the lower slide pin and retainer assembly.

TORQUE PLATE BUSHING INSPECTION

Clean and inspect the torque plate for cracks. If any cracks are found replace the torque plate.

NOTE: The caliper may be removed completely or only one side at a time for checking and servicing the torque plate.

1. Remove the slide pins as shown in " Brake Lining Removal"
2. Clean and visually inspect the bushings for wear or other damage.
3. Measure the inner diameter of the bushings at three locations (Figure 74).

NOTE: The inner diameter must not exceed 1.0003 inches (25.47 mm). The bushings must not be out of round more than 0.003 inch (0.08 mm). Replace bushings if their dimensions exceed specifications.

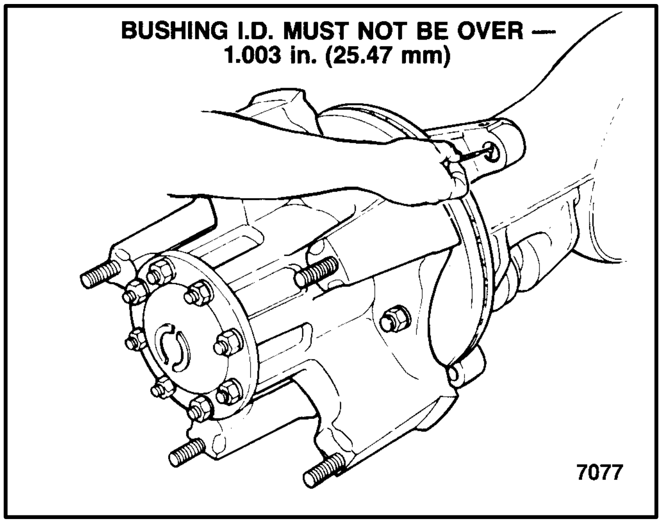


Figure 74. Measuring Inner Diameter.

NOTE: Do not replace the torque plate bushings unless they are damaged or worn beyond specification.

TORQUE PLATE REMOVAL

1. Remove caliper as shown in the "Caliper Removal" procedure.
2. Remove the rotor as shown in the "Rotor Removal" procedure.
3. Remove the nuts, bolts and washers that hold the torque plate to the knuckle and remove the torque plate.

BUSHING REMOVAL

Use a bushing driver and a mallet to remove the bushings (Figure 75).

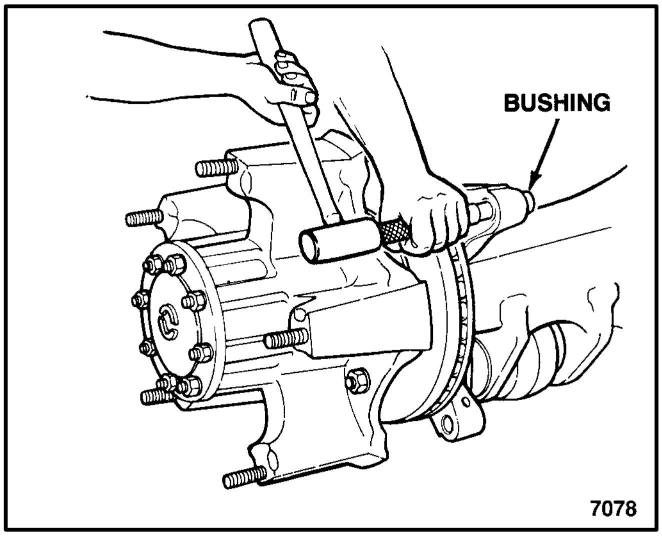


Figure 75. Removing Torque Plate Bushing.

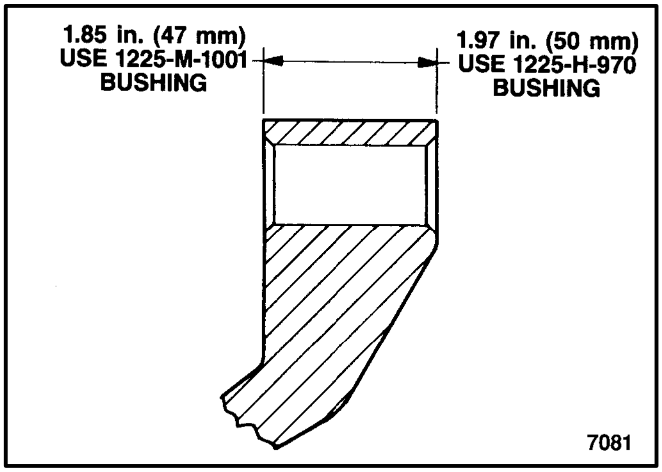


Figure 76. Torque Plate Bushing Bore.

BUSHING INSTALLATION

1. Select the correct bushing for the torque plate (Figure 76).
2. Place the bushing and driver over the center of the bore, and align the slot in the bushing with the hole for the slide pin retainer in the torque plate arm.

NOTE: If the slot in the bushing and the hole for the slide pin retainer are not aligned, the retainer cannot be installed.

3. Drive the bushing into the center of the bore (Figure 77).

NOTE: Make sure the bushing is the same distance from each end of the bore. Do not let the bushing extend past the end of the bore.

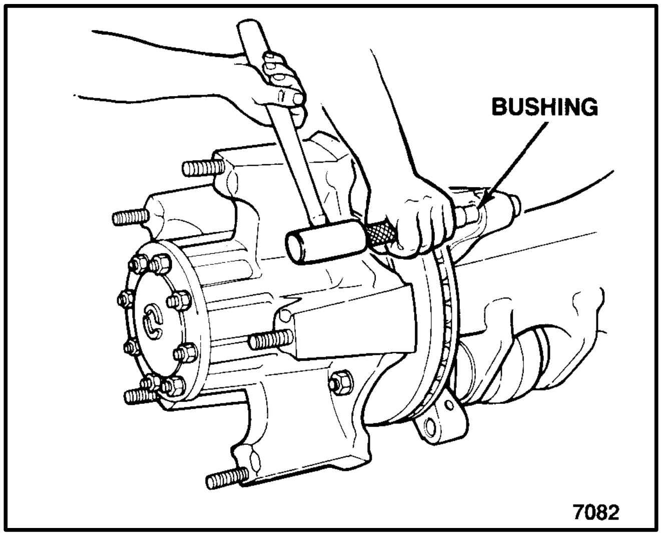


Figure 77. Installing Torque Plate Bushing.

TORQUE PLATE INSTALLATION

1. Make sure the surfaces of the torque plate and the knuckle mounting flange are clean and undamaged.

2. Position the torque plate on the knuckle, making sure the arms of the torque plate are pointing inboard.

3. Insert capscrews through torque plate and knuckle from the torque plate side, and install the washers and nuts. Using a crisscross pattern torque to 180-240 ft-lbs (244-325 N·m).

PARTS CLEANING AND INSPECTION

⚠ WARNING ⚠

If cleaning solvents, alkaline solutions or hot dip tanks are used incorrectly, serious personal injury can occur. To prevent injury, follow the instructions supplied by the manufacturer. Do not use gasoline to clean parts. Gasoline can explode or burn and cause serious injury.

Solvent cleaners can be flammable, poisonous, and can cause burns, Use safe shop practices when using solvents in the cleaning processes, and follow these rules:

- WEAR EYE PROTECTION
- WEAR CLOTHING THAT PROTECTS THE SKIN.
- MAKE SURE THERE IS ENOUGH VENTILATION
- DO NOT USE GASOLINE OR SOLVENTS THAT CONTAIN GASOLINE
- FOLLOW THE MANUFACTURERS INSTRUCTIONS FOR SAFE USE OF THE SOLVENT.

Ground or Polished Metal Parts

Use a cleaning solvent to clean metal parts and surfaces that are ground or polished. Kerosene or diesel fuel can be used as cleaning solvents.

⚠ CAUTION ⚠

Do not clean ground or polished metal parts in a hot solution tank or with water, steam or alkaline solutions. These solutions will cause corrosion of the parts.

Rough Metal Parts

Clean rough metal parts with cleaning solvents or with a weak alkaline solution in a hot solution tank. If you use a hot solution tank, leave the rough parts in the hot solution until they are completely cleaned and heated. Remove the rough parts from the hot solution tank and wash them with water until the alkaline solution is removed.

Rubber or Plastic Parts

NOTE: Do not use cleaning solvents or alkaline solutions on rubber or plastic parts or they will be damaged.

Dry Parts

Completely dry all parts immediately after cleaning them. Use soft, clean paper or cloth rags, or use compressed air.

NOTE: Do not use compressed air to dry bearings or they will be damaged.

Inspect Parts

It is very important to inspect all parts before reassembling them. Inspect the parts for any signs of wear or damage. Repair or replace any worn or damaged parts. If worn or damaged parts are not replaced, they can cause poor brake performance or a brake failure.

CORROSION PROTECTION

To prevent corrosion, apply a thin layer of brake grease to the parts that have been cleaned, dried and inspected and will be reassembling. Do NOT apply or allow grease or oil to get on the linings or rotor.

If the parts are to be stored, apply a special material that prevents corrosion and rust to all surfaces. Do not apply the material to the brake linings or the rotor. Store the parts inside special paper or other material that prevents corrosion and rust.

NOTE: To prevent corrosion and make it easier to remove the lower pin, put silastic seal in the inboard end of the hole for the retainer (Figure 78).

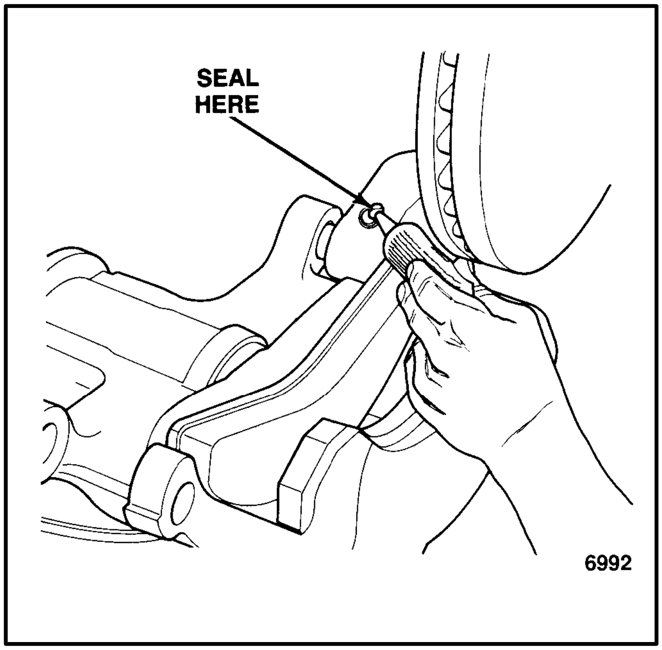


Figure 78. Sealing Retainer Hole.

BRAKE CHAMBERS

GENERAL DESCRIPTION

The service brake system utilizes chamber actuated brake assemblies on all disc brake equipped axles. The diaphragm type brake chambers convert the energy of compressed air into a mechanical force. The brake chambers are integral components in the operation of the front and trailing axle service brakes.

NOTE: The double diaphragmed brake chambers are used exclusively on the drive axles which have drum type brake assemblies only. Only the single diaphragmed brake chambers are used on front and trailing axle disc brake installations.

Several different size brake chambers are used on the D series coaches. All Rockwell front disc brake equipped axles are fitted with Type 24 brake chambers. The trailing axle of the 102DL3 is fitted with disc brakes only and utilizes Type 16 brake chambers.

All brake chambers feature anti-corrosion construction and a mechanically sealed (clamped) body for easy service. All brake chambers will require periodic inspection and maintenance.

COMPONENTS

Generally, most single-diaphragm push rod type brake chamber designs will consist of the same basic internal parts.

NOTE: Coaches built prior to October 1994 do not have stroke indicators on their brake chambers. All coaches produced after this date are fitted with brake chambers featuring a stroke indicator for quickly determining an over-extended condition (i.e., brakes out of adjustment).

PUSH ROD

The push rod connects to and relays the force of the brake chamber to the slack adjuster. Later model brake chambers incorporate an over-extension stroke alert indicator band on the push rods.

DIAPHRAGMS

The diaphragm separates the pressure and non-pressure retaining areas of the brake chamber. Diaphragms are made of reinforced rubber or other similar materials. The diaphragm is held in place by the clamping ring.

RETURN SPRING

The brake chambers typically incorporate some type of return spring mechanism. The return spring assures that the push rod will return to the unextended position after each brake application.

CLAMP RING

Bolted brake chamber clamping rings hold the different sections (service/park) of the chamber body together.

BODY

The brake chambers installed on the front and trailing axles are of different size and capacity. Body diameters and/or sectional make-up of each chamber will appear different from one axle to another. The following chart will help in identifying the specific brake chamber used. Dimension are O.D. clamping ring.

FRONT DISC (M/Grau)	**Type-24 (7-13/32” O.D.)**
TAG DISC 102DL3 (Bendix)	**Type-16 (7-13/32” O.D.)**

OPERATION

Single diaphragm brake chambers have pressure and non-pressure retaining areas. Air pressure enters the pressure retaining side of the brake chamber diaphragm, which balloons the diaphragm and moves the push rod assembly forward. When air pressure is released from the brake chamber the push rod return spring, in combination with other brake component mechanisms, returns the push rod and diaphragm to their normal position.

⚠ CAUTION ⚠

Brake chamber push rod travel should be kept as short as possible without causing brake drag. Excessive push rod travel shortens diaphragm life, gives slow braking response and wastes air. The push rod should extend and retract properly without binding.

NOTE: All pressurized brake chamber supply air is exhausted through brake system control valves.

INSPECTION

OPERATIONAL & LEAKAGE TESTING

An operational check for brake chamber push rod travel and/or leakage should be performed every 8,000 miles (12,720 km) or 300 service hours per the periodic maintenance schedule below. The inspections can be easily performed by following these simple procedures.

1. Check push rod-to-slack adjuster alignment in both the applied and released positions.

2. Check that push rod travel is as short as possible without causing any brake drag.

3. Check that the proper air system pressure is available in both reservoirs for testing brakes (90-to-100 psi).

NOTE: The air brake chamber push rod stroke can be difficult to measure properly. To determine proper brake chamber and/or slack adjuster performance, push rod stroke must be accurately measured at an 90-to-100 psi service brake application as recommended by the Commercial Vehicle Safety Alliance (CVSA).

The stated pressure range is measured at reservoir, with engine off. All excess pressure is to be dumped before the brakes are fully applied

CAUTION

Inspect for worn camshaft bushings. Camshaft bushing wear contributes to longer push rod stroke and shorter chamber service life.

The optimum slack adjuster arm and push rod intersecting angular connection should show an obtuse (more than 90 degree) angle present at the arm-to-rod connection when at rest, while a 90 degree or a slightly acute (less than 90 degree) angle might be present during full rod extension (Figure 79).

4. Check that push rod extension and retraction dimensions are within specification, and note that rod moves out and returns properly and without binding.

NOTE: The new model brake chambers will incorporate an over-extension stroke alert indicator band on the push rods. If band is observed during inspection, an over-extension condition exists and must be corrected. Refer to the at-rest and extended dimensions for those brake chambers without over-extension indicators.

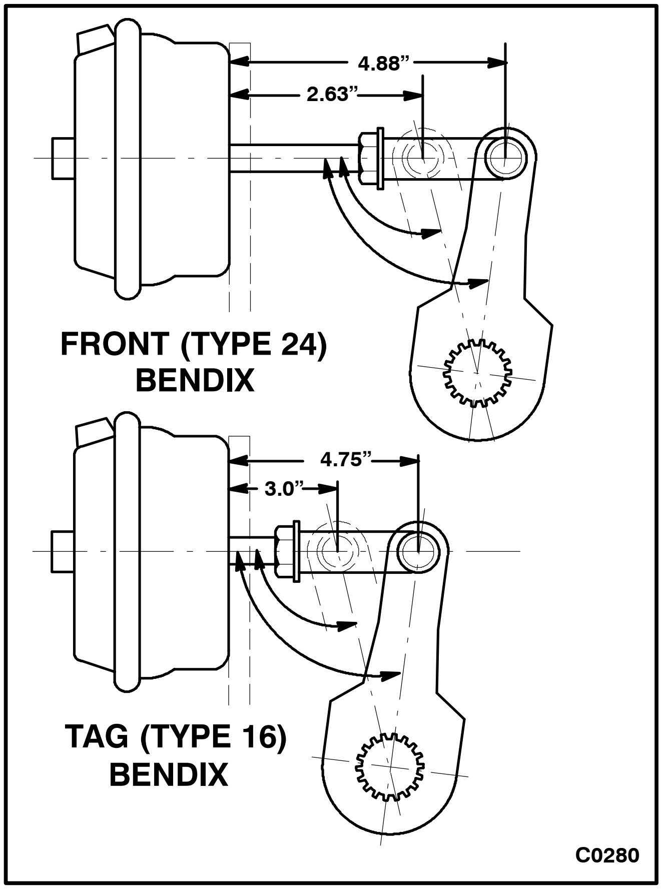


Figure 79. Push Rod Adjustments

5. With system pressure at normal operating levels, make and hold a full service brake application. Perform a soap bubble test on all clamp rings and push rod seals. Repeat this procedure with parking brake applied. No leakage is permitted under these conditions.

CAUTION

Leakage around the flange or clamping ring, could indicate uneven clamp ring fastener torques. Clamp ring capscrews should be tightened evenly, but not over torqued. Over torquing of fasteners could cause diaphragm flange sealing surface or clamping ring distortion.

6. Check brake chamber mounting torques, clamp ring fastener torques, hose routing clamps and hose connections.

MAINTENANCE

An operational check for brake chamber push rod travel and/or leakage should be undertaken every 8,000 miles (12,720 km) or 300 service hours see “Inspection” previously.

Every 100,000 miles (161,000 km) or every 3000 service hours (more often for severe service), disassemble the brake chambers. Clean and inspect all parts.

REMOVAL

1. Turn master switch to “OFF”, and block coach by means other than the park brake before lifting.
2. Exhaust all brake system air pressure.

WARNING

Exhaust all air from coach brake systems before removing any brake chamber hoses. Pressurized hoses could whip and cause personal injury.

3. Disconnect the air lines from top of the brake chamber.
4. Unfasten and remove push rod yoke from the slack adjuster, and push the rod all the way in.
5. Unfasten and remove brake chamber from mounting bracket.

NOTE: Clean exterior and match mark all chamber components before disassembly.

DISASSEMBLY

NOTE: Some chambers may be dismantled while still attached to vehicle (i.e., minor diaphragm or spring replacement).

Single Diaphragm Chambers

1. Pull push rod out and clamp with vise or vise grip pliers to relieve internal return spring tension on the pressure plate.

NOTE: Shop air may be required to extend push rod.

CAUTION

Jaws of vise or vise grip pliers should be covered or taped to prevent damage to the push rod.

2. Unfasten and remove clamp ring segments (Figure 80).

NOTE: Some chambers use full round clamping rings. Spread clamp ring slightly to slip it off the flange. Do not bend or scar clamp ring retaining lips while removing.

3. Remove the pressure plate and diaphragm.
4. Release vise or vise grip clamp on push rod and slowly allow spring to expand.
5. Remove clevis yoke and locknut from push rod, and remove push rod from chamber.
6. Clean metal parts with solvent, and inspect all metal and rubber components for cracks, distortion or other damage.

NOTE: Install new diaphragms or seals when worn or deteriorated. Diaphragm and return spring replacements should be done in sets. Both the right and left hand brake chambers of a given axle should be changed in order to maintain even brake application forces.

ASSEMBLY

Single Diaphragm Chambers

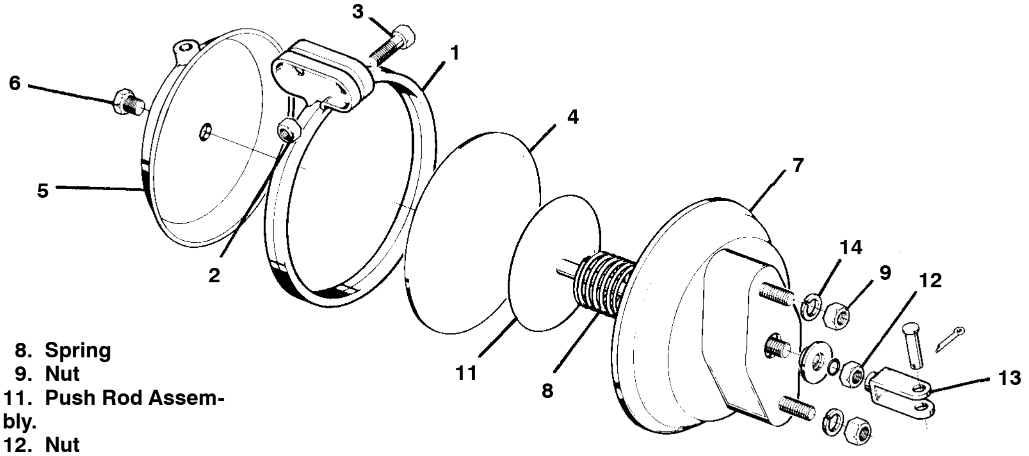
1. Install new parts and assembling in the reverse order of the disassembly procedure.
2. Apply shop air and test for air leakage before installing on coach.

INSTALLATION

1. Mount brake chamber and other brackets (i.e., leveling valve). Torque nuts on mounting studs to 30-50 ft-lbs (40.7-67.8 N·m).
2. Install clevis yoke and locknut on push rod and connect to slack adjuster arm with the clevis pin.

NOTE: Install actuators with the drain slot pointing down.

3. Connect the air lines to the chamber. Take care that the correct line is installed in the correct port.
4. Adjust brakes and test.



1. Clamp
2. Nut
3. Bolt
4. Diaphragm
5. Pressure Plate
6. Plug
7. Non-Pressure Plate Assembly.
8. Spring
9. Nut
11. Push Rod Assembly.
12. Nut
13. Yoke
14. Lockwasher

5264

Figure 80. Front and Trailing Axle Brake Chambers

SLACK ADJUSTERS - AUTOMATIC

GENERAL DESCRIPTION

The D series coaches featuring disc brake equipped axle installations use Rockwell® automatic slack adjusters exclusively. These slack adjusters provide for automatic adjusting of the disc brakes through each service application. This constant adjusting during each brake application compensates for normal brake lining wear. Only one slack adjuster mounting style is used for the disc brake equipped axle installations.

NOTE: The disc brake axle installations used on the D series coaches utilize left- or right-handed slack adjusters. These slack adjusters are location specific, and must be so positioned to work properly.

COMPONENTS

SLACK ADJUSTER

The slack adjuster casting may be configured with either a straight or offset push rod attachment arms or clevis assemblies depending on the axle installation. All Rockwell® slack adjusters incorporate an adjusting hex screw and actuator mechanism with separate actuator arm for the auto-adjust feature (Figure 81).

NOTE: The internal mechanisms of the automatic slack adjusters are not user serviceable.

CLEVIS

The clevis assemblies for attaching the slack adjuster to the brake chamber push rod are model specific. The Rockwell slack adjusters require a non-threaded, double pin clevis design connected with an internal snap ring threaded collar and jam nut to attach the slack adjuster to the push rod.

OPERATION

When the service brakes are applied, the chamber push rod extends and rotates the brake slack adjuster, which moves the shoes into contact with the drum. If the normal lining-to-drum clearance is not present, the actuator rod (also connected to clevis) would be forced into the actuator assembly.

As brake application continues, the actuator rod would cause actuator piston to move down and turn the actuator (adjusting sleeve) guided by the pawl teeth. As it turns, the actuator rotates the splined end of the adjusting worm gear. The worm gear turns and rotates the internally splined wormwheel gear, which is attached to the camshaft and adjusts the brakes.

NOTE: Rockwell® slack adjusters auto-adjust during brake applications.

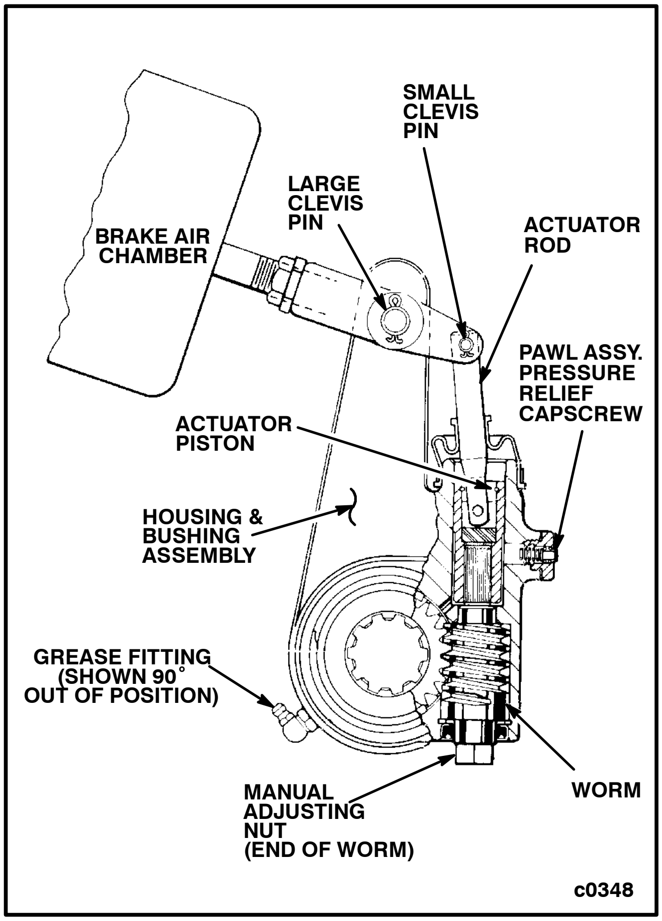

SMALL CLEVIS PIN
LARGE CLEVIS PIN
ACTUATOR ROD
BRAKE AIR CHAMBER
PAWL ASSY. PRESSURE RELIEF CAPSCREW
ACTUATOR PISTON
HOUSING & BUSHING ASSEMBLY
GREASE FITTING (SHOWN 90° OUT OF POSITION)
MANUAL ADJUSTING NUT (END OF WORM)
WORM
c0348

Figure 81. Automatic Slack Adjuster

MAINTENANCE

The Rockwell® automatic slack adjusters have completely sealed actuator mechanisms to ensure maximum service life with minimal maintenance. Some periodic inspection, lubrication and adjustment procedures will be required.

INSPECTION

Rockwell® automatic slack adjusters are fitted with a clevis pin bushing in the adjuster arm, and actuator arm boot. Inspection of both should be done at every lube interval and/or brake relining. If any significant wear are damage is evident, remove and replace.

1. Apply the coach brakes and inspect that over-stroke indicator is not visible on push rod, and also that slack adjuster rotates freely.

2. Release the brakes and check that slack adjuster and rod return to the released position freely.

NOTE: The Rockwell® slack adjuster template may be used to make approximate measurements of push rod at rest and extended dimensions, clevis position and slack adjuster to brake chamber alignments.

If the clevis is:	Use this template:	Distance "A" will be:
Offset*	TP-4788 Green	3.34 inch (84.8 mm)
Straight	TP-4789 Yellow	2.62 inch (66.5 mm)

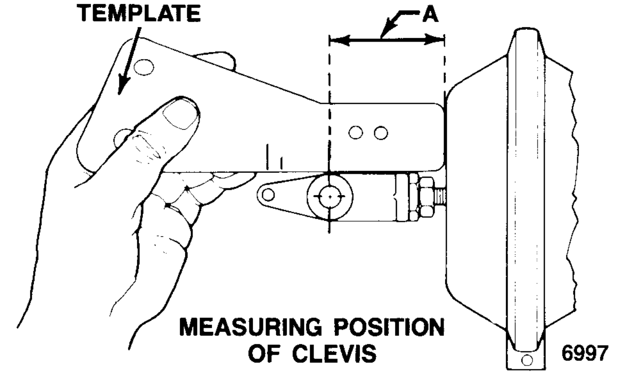


Figure 82. Position of Clevis

3. Using a Rockwell® slack adjuster template, check clevis installation for correct position and readjust if required (Figure 82).

4. The threads of the push rod and the clevis must engage for at least 1/2 inch (12.7 mm), and not extend through clevis more than 1/8 inch (3.2 mm) (Figure 83).

NOTE: If necessary, cut the push rod, install a new push rod or a new brake chamber.

5. Hold the correct hole of template on the center of the powershaft. then install both pins through the template, clevis and slack adjuster to be sure clevis is installed correctly (Figure 84 85)

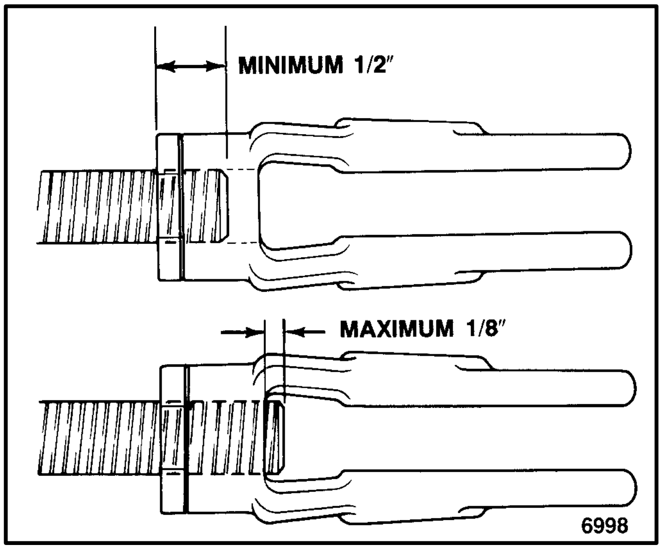


Figure 83. Brake Clevis

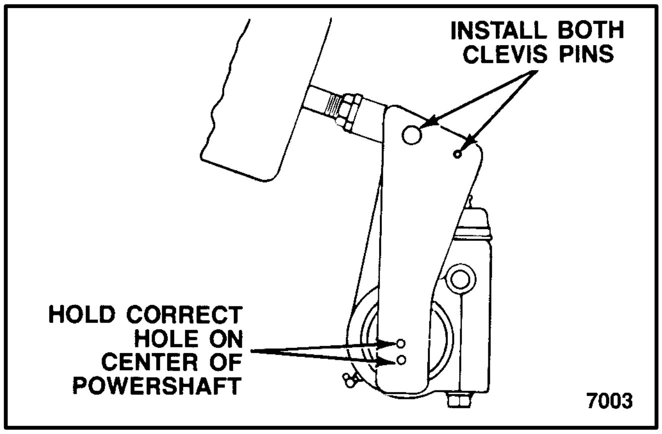


Figure 84. Slack Adjuster/Brake Chamber Installation

6. Check jamnut torque values that hold the clevis in place.

NOTE: 1/2”−20 threads require 20-30 ft-lbs (27-41 N·m), while 5/8”-18 threads require 25-50 ft-lbs (34-68 N·m) torque.

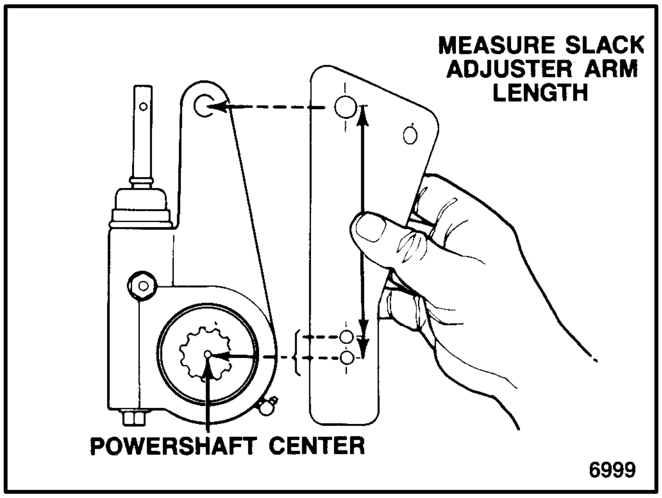


Figure 85. Slack Adjuster Length.

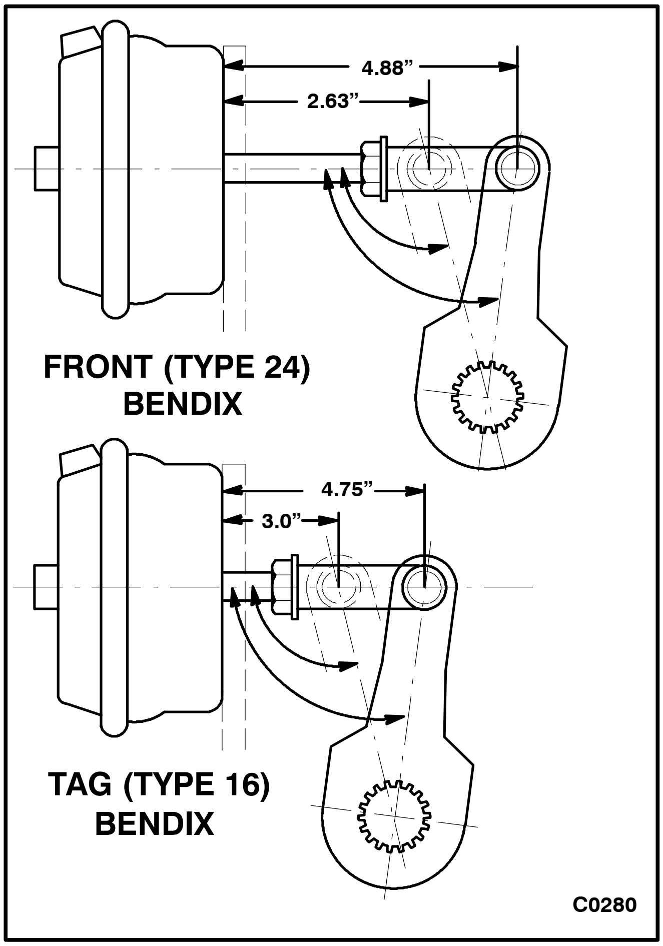


Figure 86. Push Rod Adjustments

NOTE: All slack adjusters should have an operational check performed during each lubrication interval. Follow the steps in the "Adjustment Procedures" below to check for automatic slack adjuster internal mechanism operation.

LUBRICATION

Slack adjusters must be lubricated every 5,000 miles (8,000 km) or 150 hours. Lubricate until grease flows out inboard splines (and pawl assembly). Use lubrication specification S-16 or S-19 (Multi-Purpose Grease MOBILITH AW-1 or DARINA EP-1) shown in Section 10.

ADJUSTMENT

This procedure may be used for either adjusting brakes with existing linings or after replacing linings. Some additional steps are included for making the internal mechanism's operational check.

NOTE: Wheels must be jacked and able to turn while adjusting brakes.

1. Position main battery switch to "OFF", and block coach wheels.
2. Remove the pawl assembly from the slack adjuster.

⚠ CAUTION ⚠

Rockwell® auto-adjust actuator mechanisms are fitted with an actuator guide pawl. The pawl must be removed (if old style prior to Jan. 1993) or pulled out 1/32" (if new style after Jan. 1993), before turning the adjusting hex screw in either direction. If pawl is not removed, damage to the pawl and actuator guide teeth will occur.

3. Install socket with 1/2" drive ratchet onto the adjusting hex screw of the slack adjuster.

NOTE: To perform the operational check, first manually de-adjust the brakes by turning adjusting hex screw to create an excessive clearance condition, then continue procedure. To observe adjuster in action, attach a box end wrench to the adjusting hex. Any rotation during brake application would indicate excessive clearance and that slack adjuster is adjusting for same. Automatic adjustment should decrease on each subsequent applications.

4. Turn the adjusting hex screw until the lining contacts the brake drum.
5. Back off the adjustment by turning hex screw one-half turn in the opposite direction.

⚠ CAUTION ⚠

Do not use an impact wrench to turn adjusting hex screw as damage will occur to the adjuster mechanism.

6. After adjustments are complete, make a full service brake application (90 to 100 psi.) and check push rod stroke (Figure 86), then release brakes to check lining-to-drum-clearance for proper operation.

NOTE: The air brake chamber push rod stroke can be difficult to measure properly. To determine proper brake chamber and/or slack adjuster performance, push rod stroke must be accurately measured at an 90-to-100 psi service brake application as recommended by the Commercial Vehicle Safety Alliance (CVSA).

The stated pressure range is measured at reservoir, with engine off. All excess pressure is to be dumped before the brakes are fully applied

REMOVAL

1. Position main battery switch to “OFF”, block coach wheels, release parking brake.
2. Remove the pawl assembly from the slack adjusters.

⚠ CAUTION ⚠

The pawl must be removed or pulled out before turning the adjusting hex screw. If pawl is not removed, damage to the actuator guide teeth will occur.

3. Install a socket with 1/2” drive ratchet onto the adjusting hex screw, and rotate one full turn to release brakes.
4. Remove the brake chamber push rod and actuator rod clevis pins from slack adjuster arm and remove push rod.
5. Unfasten and remove slack adjuster-to-brake powershaft retaining hardware (i.e., capscrew or snap ring).
6. Slide the slack adjuster and spacer washers off the spine end of the powershaft.

NOTE: Mark all spacer washers for reinstalling in their proper positions.

INSTALLATION

1. With main battery switch still “OFF” and wheels blocked, make sure that all brake chamber push rods are fully retracted.
2. Apply anti-seize compound to the powershaft splines.

NOTE: Install slack adjuster onto powershaft splines so arm attachment hole is in near alignment with clevis pin hole (Approximately one full turn of the adjusting hex screw). Slack adjuster may require repositioning on the powershaft spline to achieve correct adjustment.

3. Reinstall any spacer washers on powershaft, and slide slack adjuster onto the end of the powershaft.
4. Install any other spacer washers, and secure slack adjuster with appropriate fasteners.

NOTE: When installing a slack adjuster, clearance must be allowed to ensure that the slack adjuster can be rotated to the maximum stroke of the brake chamber. Install the grease fitting and locate the slack adjuster on the powershaft in such a manner as to allow both the adjuster screw and grease fitting easy access when servicing.

5. Rotate the adjusting hex screw to align slack adjuster arm attachment hole with rod clevis (moving linings outward), and install the brake chamber push rod clevis pins.

⚠ CAUTION ⚠

Do not force the adjuster into position to align the clevis holes. Use only the adjusting nut.

6. Manually adjust the brakes using steps 2 through 5 of the “Adjustment” procedure.
7. Reinstall the pawl assembly into the actuator mechanism and torque to 15-20 ft-lbs (20-27 N·m).
8. Lubricate the slack adjuster and make an “Operational Check” after installation.

TROUBLESHOOTING

REPORTED COMPLAINT/ COMMON SYMPTOMS	POSSIBLE CAUSE(S)	WHAT TO CHECK FOR	CORRECTIVE ACTION
1. Poor Stopping Power • Long stopping distances • Poor driver feel • High brake pressures	Coach air system malfunction	• Check for proper air pressure at the chamber inlet.	• Have air system evaluated by a qualified brake system specialist.
	Brakes out of adjustment	• Check stroke. • Check installation with auto slack template. • Check jamnut torque. • Check clevis wear. • Check pawl wear.	• Repair, replace parts as required. • Adjust to recommended stroke. • Correct set–up & check with template. • Tighten as required.
	Coach overload	• Check for overloading — see GAWR limitations on coach I.D. plate.	• Observe coach manufacturer's load recommendations.
	Contamination on linings	• Check for grease, oil, etc., on linings.	• Replace linings.
	Companion coach brakes not working properly	• Inspect companion coach brakes and air system.	• Adjust or repair as required.
2. Brake Not Functioning • Lack of normal response	See #1	_____	• As required — see #1.
	Internal caliper failure	• Movement of load plate piston when actuating auto slack.	• Disassemble and overhaul caliper.
3. Coach Pulls to One Side When Stopping	See #'s 1-2	_____	• See #'s 1-2
4. Brake Drag • Evidence of severe heat • Rapid lining wear discoloration of rotor braking surface • Torn or charred piston/caliper boot seal	Incorrect manual adjustment	• Check auto slack set-up. • Check for correct running clearance pad-to-disc (rotor).	• Correct set-up. Adjust to recommended stroke and running clearance. Check with template.
	Coach air system malfunction	• Check for proper operation of quick release valve and relay valve.	• Repair or replace parts as required.
	Brake not releasing	• Coach air system leakage.	• Find source of leak and repair as required.

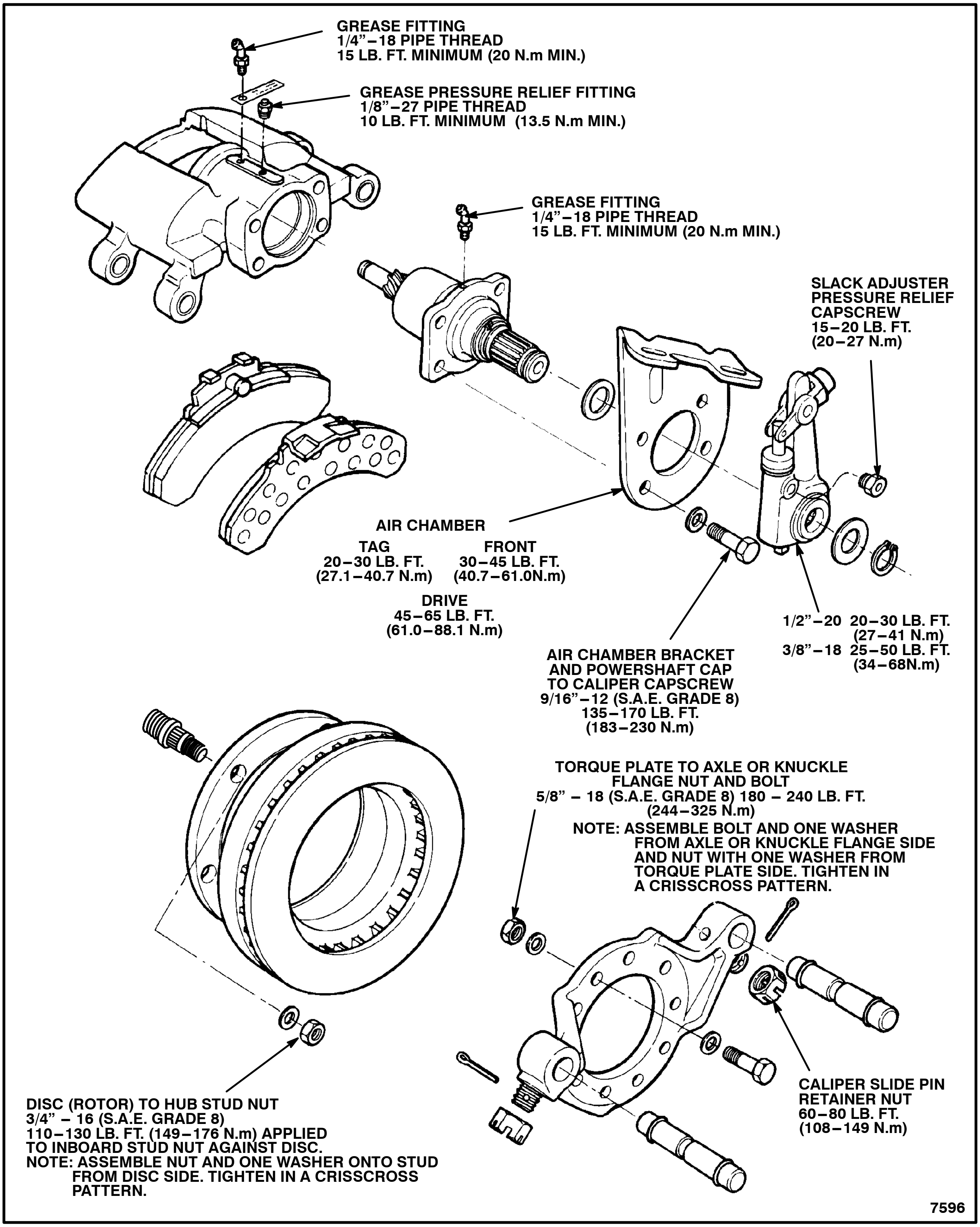
TROUBLESHOOTING (Contd.)

REPORTED COMPLAINT/ COMMON SYMPTOMS	POSSIBLE CAUSE(S)	WHAT TO CHECK FOR	CORRECTIVE ACTION
		• Brake chamber malfunction.	• Repair or replace brake chamber as required.
		• Slow build–up of emergency air pressure.	• Wait for full build-up before driving.
		• Incorrect air pressure range at compressor/governor.	• Set compressor/governor to correct pressure range.
	Excessive grease pressure in caliper.	• Incorrect lube procedures.	• Follow lubrication recommendations.
	Internal corrosion of caliper assembly	• Check piston boot and caliper seals.	• Replace seals as required. Inspect and overhaul caliper assembly as required.
5. Short Outboard Lining Life • Brake drag	Caliper seized on slide pins.	• Excessive paint or other foreign build–up on caliper slide pins or bushings.	• Remove both pins. Clean, inspect and replace pins and bushings as required.
	Misalignment of slide pins.	• Caliper should move back and forth with hand effort (20-30 ft-lbs).	• Remove pads. Clean, inspect and replace slide pins and bushings as necessary. Install caliper and slide pins without pads. Tighten retainer nuts. Check that caliper slides freely on slide pins. If problem continues, check axle mounting flange for nicks, burrs or gouges. Repair as necessary. Install torque plate and caliper and check again for free movement.
6. Short Lining Life	See #'s 4-5	_____	• See #'s 4-5
	Abusive use of brake system	• Check driver technique.	• Implement driver training.
	Coach overload	• Check for overloading. See GAWR limitations on coach I.D. plate.	• Observe coach manufacturer's load recommendations.
	Companion coach brakes not working properly	• Inspect companion coach brakes and air system.	• Adjust or repair as required.

TROUBLESHOOTING (Contd.)

REPORTED COMPLAINT/ COMMON SYMPTOMS	POSSIBLE CAUSE(S)	WHAT TO CHECK FOR	CORRECTIVE ACTION
7. Pad Backing Plate Tab Wear	Brinnelling of pad tab area	• Check for signs of brinnelling and back and forth movement of pad in caliper.	• Remove and replace pads. Check anti-rattle clip. If wear is excessive, replace caliper assembly.
8. Failed Disc (Rotor) Cracked or Broken	See #'s 4, 5, 6	____	
	Failure to perform routine checks on lining wear and caliper position on pins	• Check disc (rotor) for minimum thickness.	• Replace disc (rotor), shoes and linings as required. Review proper maintenance procedures with personnel.
9. Slide Pins/Retainer Pin Assemblies Hard to Remove	Highly corrosive environment	• Check for signs of corrosion.	• Inspect slide pins and retainer pin assemblies. Replace as required. Apply anti-seize compound to retainer, but not to threads. • Seal inner end of lower slide pin retainer hole in torque plate.
10. Brake Smoking	Leaking hub or wheel seal	• Check condition of seals.	• Replace as required. Clean disc (rotor) as required. Inspect pads and replace if oil-soaked.
	Leaking caliper sealing components	• Check condition of piston boot, piston cap seal and piston/caliper seal.	• Replace as required.
	Piston boot popped out of piston seating groove	• Check for excessive lubrication of caliper. Inspect piston boot position.	• Follow lubrication recommendation. Replace piston boot if required.
	Paint on slide pins and/or brake	• Check all painted surfaces.	• Clean slide pins and brake as required.
	High brake temperature	• Check #'s 1,4,5,6	• See #'s 1,4,5,6

MISCELLANEOUS TORQUE SPECIFICATIONS


GREASE FITTING
1/4”−18 PIPE THREAD
15 LB. FT. MINIMUM (20 N.m MIN.)
GREASE PRESSURE RELIEF FITTING
1/8”−27 PIPE THREAD
10 LB. FT. MINIMUM (13.5 N.m MIN.)
GREASE FITTING
1/4”−18 PIPE THREAD
15 LB. FT. MINIMUM (20 N.m MIN.)
SLACK ADJUSTER
PRESSURE RELIEF
CAPSCREW
15−20 LB. FT.
(20−27 N.m)
AIR CHAMBER
TAG
20−30 LB. FT.
(27.1−40.7 N.m)
FRONT
30−45 LB. FT.
(40.7−61.0N.m)
DRIVE
45−65 LB. FT.
(61.0−88.1 N.m)
1/2”−20 20−30 LB. FT.
(27−41 N.m)
3/8”−18 25−50 LB. FT.
(34−68N.m)
AIR CHAMBER BRACKET
AND POWERSHAFT CAP
TO CALIPER CAPSCREW
9/16”−12 (S.A.E. GRADE 8)
135−170 LB. FT.
(183−230 N.m)
TORQUE PLATE TO AXLE OR KNUCKLE
FLANGE NUT AND BOLT
5/8” − 18 (S.A.E. GRADE 8) 180 − 240 LB. FT.
(244−325 N.m)
NOTE: ASSEMBLE BOLT AND ONE WASHER FROM AXLE OR KNUCKLE FLANGE SIDE AND NUT WITH ONE WASHER FROM TORQUE PLATE SIDE. TIGHTEN IN A CRISSCROSS PATTERN.
CALIPER SLIDE PIN
RETAINER NUT
60−80 LB. FT.
(108−149 N.m)
DISC (ROTOR) TO HUB STUD NUT
3/4” − 16 (S.A.E. GRADE 8)
110−130 LB. FT. (149−176 N.m) APPLIED TO INBOARD STUD NUT AGAINST DISC.
NOTE: ASSEMBLE NUT AND ONE WASHER ONTO STUD FROM DISC SIDE. TIGHTEN IN A CRISSCROSS PATTERN.
7596

SERVICE TOOLS

Kent-Moore Service Kit	J-34064-B
Rockwell Template	TP-4789
Spring Retainer Adapter	J-33860
Boot Adapter	J-33862-1
Bearing & Nut Assembly	J-33862-2
Bushing Plug Gauge	J-34064-53
Bushing Pin Gauge	J-34064-54
Bushing Reamer	J-38388
Snap Ring Pliers (455)	

NOTE: The drivers can be made from the information found herein, or purchased from Kent-Moore. Heavy Duty Division, 29784 Little Mack, Roseville, Michigan, 4866-2298.

SPECIFICATIONS

BRAKE LINING KIT

Manufacturer	Rockwell International
Part Number (One Side)	4L-1-47
Part Number (Both Sides)	4L-1-48

SLIDE PIN BUSHING REPAIR KIT

Manufacturer	Rockwell International
Part Number	4L-1-49

SLIDE PIN REPAIR KIT

Manufacturer	Rockwell International
Part Number	4L-1-50

CALIPER MINOR REPAIR KIT

Manufacturer	Rockwell International
Part Number	4L-1-51

CALIPER MAJOR REBUILD KIT

Manufacturer	Rockwell International
Part Number (LH)	4L-1-52
Part Number (RH)	4L-1-53

POWERSHAFT CAP MINOR REPAIR KIT

Manufacturer	Rockwell International
Part Number	4L-1-66

BUSHING & SEAL KIT (POWERSHAFT CAP)

Manufacturer	Rockwell International
Part Number	4L-1-65

BRAKE ROTOR

Manufacturer	Rockwell International
Part Number	15L-5-29

BRAKE CHAMBERS - FRONT

Part Number	4L-2-3 (RH/LH)
Manufacturer	Bendix
Type	24
Diameter	7-13/32” (187.7 mm)
Stroke	2-1/4” (57.1 mm)
Volume	59 cu in.(380.7 cu. cm)

BRAKE CHAMBERS - TRAILING

Part Number	4L-5-3 (RH/LH)
Manufacturer	Bendix
Type	16
Diameter	6-1/2” (165.1 mm)
Stroke	2-1/4” (57.1 mm)
Volume	43 cu in.(309.6 cu. cm)

SLACK ADJUSTER - FRONT

Part Number	4L-3-5 (LH) 4L-3-4 (RH)

SLACK ADJUSTER -TRAILING

Part Number	4L-6-16 (LH) 4L-6-17 (RH)

SECTION 4D

AIR CONTROL COMPONENTS

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	4D-1
Components	4D-1
Maintenance	4D-4
Specifications	4D-22

GENERAL DESCRIPTION

The complete air system incorporates numerous control components and devices for regulating the pressurized air used within each of the coach air systems. Most of the control and regulating devices used on the service brake, suspension and accessory air systems are addressed in this section. Most of these components will require some periodic maintenance.

COMPONENTS

PARK VALVE

The Bendix PP-2 push/pull park brake control valve is used to control the application and release of the park brake by interrupting the flow of air to the SV-1 control valve of the park brake release interlock assembly. The valve also exhausts any accidental service applications in park mode to control compounding service and emergency brakes. The park brake valve supply port is connected to the park/emergency reservoir. The park brake valve delivery port is connected to the SV-1 supply port. The park brake valve exhaust port is connected to the brake valve's primary delivery port.

BRAKE VALVE

The Bendix E-10 and E-15 brake valves are remote mounted, treadle-actuated, dual circuit type of valve. This valve features two separate supply and delivery circuits for application of primary and secondary service brakes, and emergency modulated braking. The primary air circuit is controlled by the upper portion of the valve, while the lower portion controls the secondary circuit.

NOTE: Effective with unit 47839 the E-10 brake valve was replaced with the E-15 valve. The E-10-R and E-15-R valves are used with retarder installations.

The brake valve primary and secondary supply ports are connected directly to the primary and secondary reservoirs. The brake valve primary service delivery port is connected to the service R-14 control port. The brake valve secondary service delivery port is connected to the QR-1 supply port.

Additionally, both the primary and secondary delivery ports route air to the preliminary and secondary stoplight switches, and on to the park brake interlock assembly for exterior brake lights and interlock functions. Primary and secondary supply air lines are routed from the brake valve to a dual air gauge for display. A primary delivery port line routes air to the exhaust port of the park brake valve for anti-compound purposes. A secondary delivery line routes air to the supply port of the emergency standby valve, and a primary supply line routes air to the control port for emergency modulated brake applications.

BRAKE PEDAL ASSEMBLY

The MCI brake pedal assembly actuates the brake valve through a rod and linkage arrangement. The welded metal pedal is covered with a black rubber tread. The pedal assembly floor mounting plate incorporates lugs for pedal pivot and stop rod mounting. The mounting plate is also used to attach the electronic accelerator pedal assembly.

QUICK-RELEASE VALVE

The Bendix QR-1 quick-release valve is a rapid exhaust valve used in the secondary service brake circuit. This valve is mounted in the spare tire area. The quick release valve supply port is connected to the E-10 secondary service delivery port. The RH/LH front brake chambers are connected to the delivery ports of the QR-1 valve.

RELAY VALVE

The Bendix service R-14 brake relay valve is used in the application and release of the rear drive and trailing axle service brakes. The R-14 speeds up application of the rear service brakes. The relay valve is mounted to the channel assembly between the drive and tag axles.

The control port of the service R-14 is connected to the primary delivery port of the E-10 brake valve. The supply port is connected to the primary service reservoir. Two of the delivery ports connect to the service portion of the drive axle DD3 brake chambers, while two others are connected to the trailing axle brake chambers.

NOTE: The balance port is not used with the D series dual circuit brake system, and therefore remains plugged.

The Bendix service R-12 relay valve is used in both the rear rise features and the newer kneeling systems. In the kneeling feature, the control port of the service R-12 is connected to solenoid 1; the supply port is connected to the supply air; and the two delivery ports connect to the bellows.

In the rear rise feature, the control port of the service R-12 is connected to a three-way solenoid control valve; the supply port is connected to the supply air and an air tank reservoir; and the two delivery ports connect to the two-way check valves.

ANTI-LOCK VALVE

The Bendix M-21 anti-lock modulator valve is a high capacity, solenoid operated, on/off air valve that controls the flow of air to the brake chamber on all anti-lock brake installations. This valve is mounted to the channel assembly on rear axle installations, and to the front bogie panel on front installations.

The primary service RH/LH modulator valve supply ports are connected to the R-14 relay valve rear axle delivery ports. The primary service RH/LH modulator valve delivery ports are connected to the service portion of the DD3 brake chamber. The secondary service RH/LH modulator valve supply ports are connected to the QR-1 quick release valve delivery ports. The secondary service RH/LH modulator valve delivery ports are connected to the front brake chambers.

INVERSION VALVE

The Bendix TR-2 inversion valve is a pilot-operated, inverting, on-off, two-way valve. The valve has three common control ports, a supply port and a delivery port. The valve is used in conjunction with the DD3 chamber and park brake circuit to control the emergency application of air, and also to keep locks released during normal service application The inversion valve is mounted on the rear drive axle.

The supply port is connected to the delivery port of the park brake regulator. The delivery is connected to one supply port of the emergency double check. Two of the common control ports are connected to the RH/LH lock ports of the DD3 brake chambers. The remaining control port is connected to the control port of the interlock assembly synchro valve, which is interconnected to the delivery of the secondary double check valve.

EMERGENCY STANDBY VALVE

The Bendix TR-2 inversion valve is also used in the control circuit for emergency park brake applications, and modulated braking of the secondary circuit. This valve is used in conjunction with the emergency brake application double check valve. This valve is located inside the tire compartment.

The supply port is connected to the secondary delivery port of the brake valve. The delivery is connected to the other supply port of the emergency double check. One of the common control ports is interconnected to the park valve supply, for emergency filling. The other control port is connected to the primary supply port of the brake valve.

PRESSURE PROTECTION VALVE

The Bendix PR-2 pressure protection valve is a normally closed, pressure regulating or sequence valve. This valve is installed in line between the wet tank, the park/emergency and the accessory reservoir junction block, to protect the suspension bellows and other components from over or under pressurization condition.

The supply port is connected to the delivery port of the suspension air filter. The delivery port is interconnected to the park/emergency reservoir, the suspension air system and the accessory air system components via the front and suspension/accessory junction blocks.

NOTE: Effective with unit 48314, the main pressure protection valve was changed. The old valve was set to close at 65 psi and re-open at 75-80 psi The new valve is set to close at 80 psi and re-open at 95 psi.

In the newer kneeling systems, this valve is mounted on the channel assembly in the front control box. The supply port is connected to system air. The delivery port is connected to solenoid 1.

In the rear rise system, the valve is mounted on the air tank reservoir in the right rear wheelhousing inside the engine compartment. The supply port is connected to junction block air supply service and air tank reservoir. The delivery port is connected to a reducer.

RESERVOIRS

Reservoirs store compressed air so there will be an ample supply for immediate use. Five air reservoirs are used in the coach air systems. One wet tank, two (primary/secondary) service brake system reservoirs, one park/emergency and one suspension/accessory system reservoir.

The primary and park/emergency tank are mounted to the rear bulkhead. The wet tank and the secondary reservoir are mounted to the front bulkhead. The suspension/accessary reservoir is mounted inside the front LH side service door.

The 102DL3 rear rise feature has an additional air reservoir mounted in the right rear wheelhousing inside the engine compartment. This supply air tank inlet connects to the junction block air supply service, the pressure protection valve and a reducer. The air tank outlet connects to the supply port of the R-12 valve via a check valve.

CHECK VALVES

The Bendix DC-4 double check valves control the distribution of air between components and/or circuits. The higher pressure air at one of two supply ports moves the blocking disc valve from its seat and allows flow out the delivery port. The check valve is responsible for the emergency application of parking brakes and mounted on the inversion valve delivery port.

Double check valves are also used in both the kneeling and rear rise features. The two double check valves of the kneeling system are mounted on the front bogie panel inside the wheelhouse. These valves are connected to pressure switch 1, RH/LH bellows, and to the two delivery ports on the R-12 relay.

The rear rise double check valves are mounted inside the drive axle wheelhouse on the channel assembly. These valves are connected to the left and right bellows and to the two delivery ports on the R-12 relay.

In-line check valves are placed in an air line or onto a reservoir inlet/outlet to allow air flow in one direction and to prevent the flow of air in the opposite direction. An arrow indicating the direction of air flow is cast into the body of the valve. Air flow in the normal direction moves the disc or ball valve from its seat and the flow is unobstructed. Flow in the reverse direction is prevented by the seating of the disc or ball valve.

PRESSURE REGULATOR

The Williams pressure regulating valves control the pressures within the different air system circuits. They remain open until delivery pressure meets the set pressure of the valve. The park brake regulator is located on the rear channel between the drive and trailing axles. The A/C compressor drive belt tension control is mounted on the RH side of the engine compartment.

The supply port of the park brake regulator is connected to the park/emergency reservoir. The delivery port is connected to the supply port of the inversion valve. The supply port of the A/C belt tension regulator is connected to the delivery port of the tension control valve. The delivery port is connected to the rear side of the double-acting tension cylinder.

AIR FILTER

A Bendix Type E element filter cleans air for the suspension, accessory air systems components and the emergency park reservoir air circuit The filter is mounted adjacent to the secondary air reservoir behind the front axle. The supply port is connected to the wet tank, and the delivery is connected to the supply port of the pressure protection valve

> **NOTE:** Effective with 48249 this filter was replaced with an inline type filter mounted on the wet tank supply.

Other line filters may also be utilized in various other air circuits. For instance the retractable step control valve and the main hot water valve assemblies use a Norgren air filter assembly. These filters are found near the components that they protect. The suspension leveling valves air circuits have small in-line filters installed upstream of each valve.

TRAILING AXLE UNLOADING VALVES

The Watts dual tag axle unloading control valves are full-port, manually-operated trailing axle air dump/fill valves. The valves provide for the exhausting and filling of the trailing axle air springs as conditions require. The dual valve installations are mounted to the upper front of the RH rear side service door frame. Both control valve supply ports are connected to the drive axle suspension bellows, while the delivery ports are connected to the trailing axle bellows.

TRAILING AXLE CASTER CONTROL VALVE

The Norgren solenoid actuated trailing axle castering control valve automatically operates the latching and locking mechanisms air cylinders of the self-steering system in conjunction with the speed switch. The trailing axle caster control valve is mounted inside the rear junction box. The control valve supply port is connected to the air/fuel junction block.

Two of the delivery ports from the valve first stage connect to the bottom or retracting port of the locking cylinder, and to the rear or extending port of the latching cylinder. Two other delivery ports from the valve second stage connect to the top or extending port of the locking cylinder, and to the front or retracting port of the latching cylinder.

LOW PRESSURE SWITCH

Two Texas Instruments low air pressure switches are installed on the primary and secondary air circuits. The switches give an automatic warning to the driver when air pressure is below the minimum for safe vehicle operation. The switches operate an electronic buzzer and telltale warning light. One switch is located in the rear junction box, and connected to the rear air/fuel junction block. The other switch is located in the tire compartment and connected to the wet tank.

BRAKE LIGHT SWITCH

The Williams pressure activated preliminary stop/park and secondary stop/fast idle light switches operate in conjunction with brake valve and park brake interlock circuits when applied. The switches are mounted to the center rear of the tire compartment. Primary and secondary delivery from brake valve is connected to the side port of the preliminary and secondary switch assemblies respectively. The top port is connected to the delivery side of the synchro valve.

AIR HORNS AND VALVE

Dual air horns are provided as a warning device. The vibrating diaphragm type horns create a signal of greater volume and carrying qualities than normal automotive electric horns. The horns are mounted in a horizontal position at the front of the front LH side service door.

The horns are operated by a floor mounted, foot-operated air valve. Pressing down on the valve stem opens the supply port to delivery. The valve is located on the driver's foot rest. The supply port is connected to the accessory reservoir, and the delivery is connected to the horn inlet valve.

INVERSION VALVE (FAN CLUTCH)

The Bendix TR-3 inversion valve is a pilot-operated, inverting, on-off, two-way valve. The valve has a single control port, supply port and delivery port. The valve is used in conjunction with the radiator fan clutch circuit to control the application of air to the air clutch mechanism. The inversion valve is mounted on the right rear of the radiator assembly.

The supply port is connected to a common supply line of the shutterstat. The delivery is connected to the exhaust port of the air valve. The control port is connected to the delivery of the shutterstat. The delivery of the air valve is connected to the fan clutch.

NOTE: Some coaches may incorporate other valves for second fan clutch or shutter operations interconnect to the radiator control circuit.

MAINTENANCE

PARK VALVE

The parking brake control valve should be removed, disassembled, and cleaned and lubricate every 50,000 miles (80,000 km) or 1,500 hours (Figure 1). Use lubrication specification S-26 (Silicon Grease - DOW CORNING 55 O-Ring Lube) as shown in Section 10 of this manual. Inspect all parts subject to wear and replace if worn, damaged or deteriorated.

NOTE: The silicone grease has a temperature operating range from -65˚F to 300˚F (-54˚C to 149˚C).

Removal

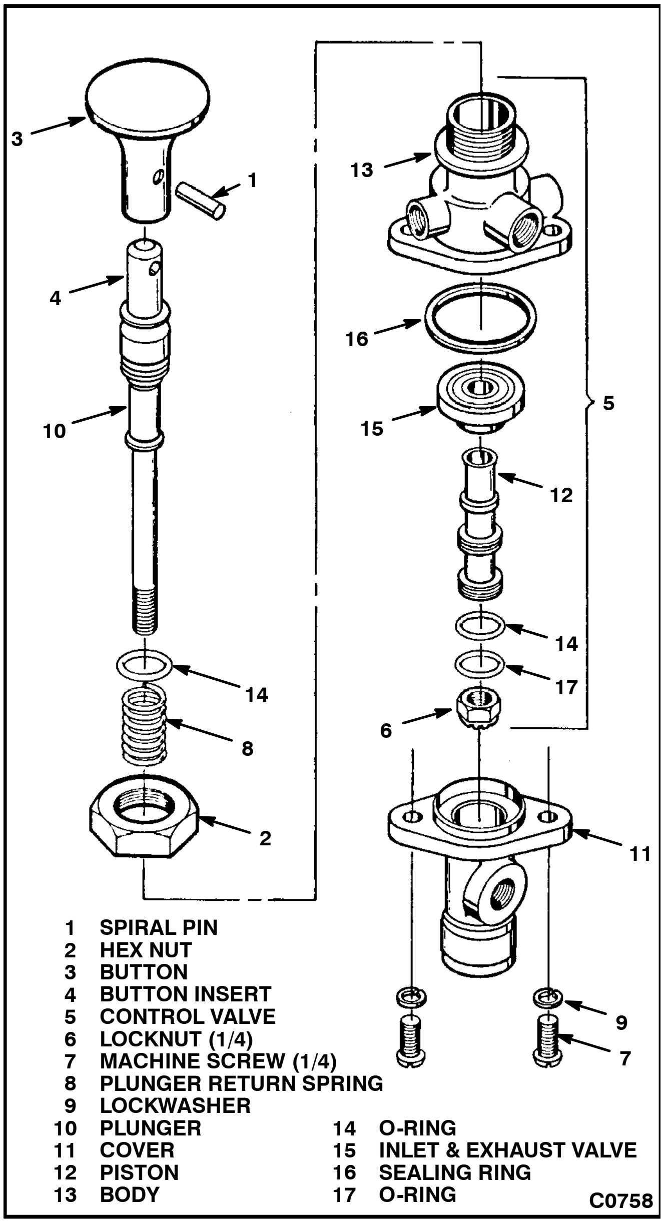
1. Place battery disconnect switch to "Off". Block or hold vehicle by some means other than air brakes.
2. Drive roll pin from the valve knob and shaft, then remove the knob.
3. Drain air pressure from all air reservoirs.
4. Unfasten and remove the exterior console panel to gain access to the park brake valve air lines.
5. Bleed pressure from the supply and delivery lines of the valve, then remove air lines from the valve.
6. Remove the control valve mounting nut, and pull the control valve out.

Disassembly

1. Insert a rod or punch in the plunger pin hole to keep the plunger from turning while removing the nut and washer from bottom of the valve.
2. Remove plunger, spring and O-ring from the valve body.
3. Unfasten and remove the lower cover.
4. Remove inlet/exhaust valve and piston from the valve body, and remove the O-rings from the piston.

Cleaning and Inspection

Wash parts in a cleaning solvent and dry thoroughly. Inspect all parts for excessive wear or deterioration. Inspect plunger and piston bores for nicks and burrs. Check body for distortion or wear and replace any parts not considered serviceable.



1	SPIRAL PIN
2	HEX NUT
3	BUTTON
4	BUTTON INSERT
5	CONTROL VALVE
6	LOCKNUT (1/4)
7	MACHINE SCREW (1/4)
8	PLUNGER RETURN SPRING
9	LOCKWASHER
10	PLUNGER
11	COVER
12	PISTON
13	BODY
14	O-RING
15	INLET & EXHAUST VALVE
16	SEALING RING
17	O-RING

Figure 1. Park Brake Valve

Assembly

1. Lubricate O-rings and bore surfaces, and reassemble in reverse order of the “Disassembly” procedure.

2. Perform the “Operation and Leakage Test” on the valve before installation.

Operating and Leakage Test

1. Connect a 120 psi air source to the supply port. An accurate test gauge should be connected to the supply port and a means of controlling the supply pressure provided. Apply a small volume of air along with a gauge to the delivery port.

2. With the button pulled out (exhaust position), leakage at the brake valve port or at the plunger stem should not exceed a 1-inch bubble in five seconds.

3. With the button pushed in, supply should open to delivery port. Leakage at the exhaust port or at the plunger stem should not exceed a 1-inch bubble in five seconds

4. Pull the button out again, and apply pressure to the brake valve port. Air pressure should be present at delivery port. Leakage at the exhaust port should not exceed a 1-inch bubble in five seconds

NOTE: If the valve does not function as described or if leakage is excessive, the valve should be replaced.

Installation

1. Reinstall the park valve in the reverse order of the “Removal” procedure, and test the valve for proper operation.

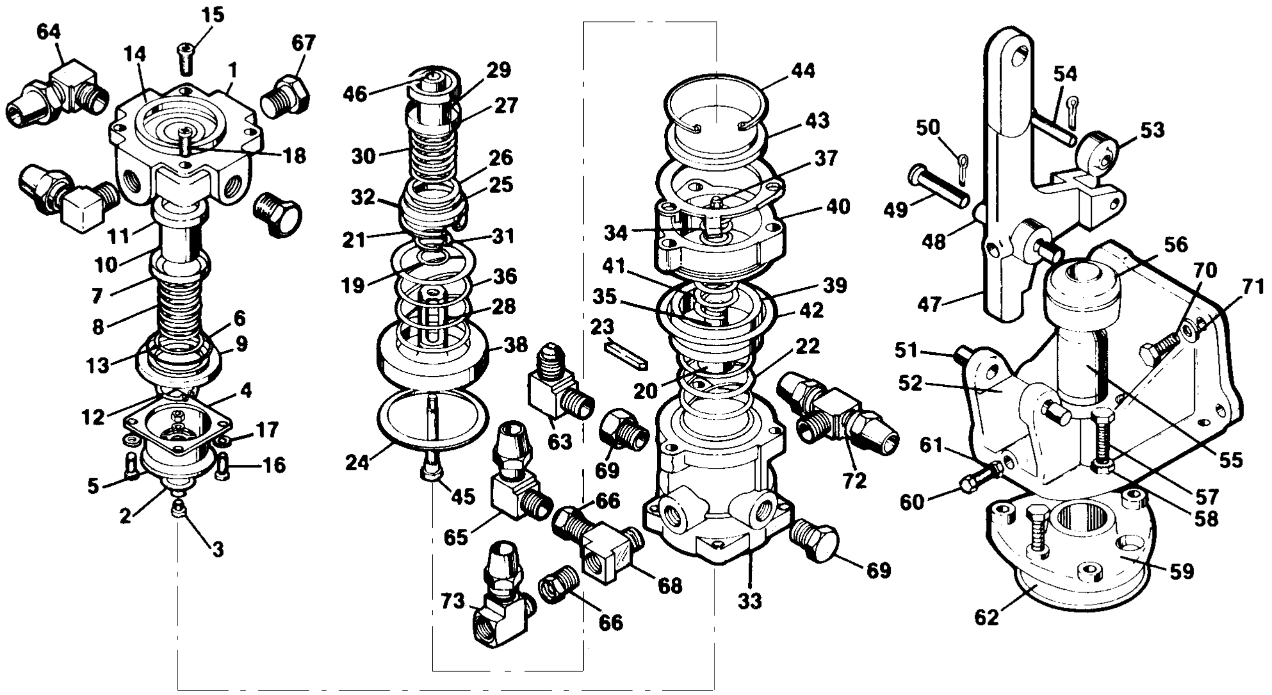
BRAKE VALVE

The brake valve should be periodically inspected, cleaned, removed, disassembled and lubricated at regular intervals. Replace parts if worn, damaged or deteriorated (Figure 2). The E-10-R and E-15-R brake valves are used with transmission retarder installations, and incorporate additional pressure switches related to retarder function.

⚠ WARNING ⚠

A change in vehicle braking characteristics or a low pressure warning may indicate a malfunction in one of the brake circuits. Although the vehicle air system may continue to function, the vehicle should not be operated until the necessary repairs have been made. Always check the vehicle brakes after performing brake system maintenance before returning the vehicle to service.

Every 25,000 miles (40,000 km), 750 operating hours, make a “Service Check” and “Leakage Check”. Clean any accumulated dirt from exterior of brake valve, and inspect the condition of plunger boot for cracks or other damage. Lubricate the plunger using lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) as shown in Section 10 of this manual.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1. LOWER BODY
2. WASHER, DIAPHRAGM
3. SCREW
4. COVER, EXHAUST
5. DIAPHRAGM, EXHAUST
6. O-RING
7. RETAINER, VALVE
8. SPRING, VALVE
9. RETAINER, O-RING
10. VALVE, INLET & EXHAUST
11. BODY
12. RETAINING RING
13. O-RING
14. BODY, LOWER
15. SCREW, MACHINE
16. SCREW, MACHINE
17. LOCK WASHER
18. CAPSCREW
19. O-RING
20. O-RING
21. RETAINING RING
22. SPRING, PISTON RETURN
23. FILTER, VENT
24. O-RING
25. O-RING
26. O-RING
27. RETAINER, VALVE
28. VALVE, INLET & EXHAUST
29. BODY
30. SPRING
31. RETAINING RING
32. RETAINER, O-RING
33. UPPER BODY
34. GUIDE, SPRING
35. GUIDE, SPRING
36. SPRING, PISTON
37. LOCK NUT
38. PISTON, RELAY
39. PISTON, PRIMARY
40. ADAPTER, UPPER
41. SPRING
42. O-RING
43. RETAINER, SPRING
44. RETAINING RING
45. STEM
46. WASHER
47. LEVER
48. BUSHING
49. PIN
50. COTTER PIN
51. BUSHING
52. MOUNTING BRACKET
53. ROLLER
54. PIN
55. PLUNGER
56. BOOT
57. CAPSCREW
58. LOCKWASHER
59. ADAPTER PLATE
60. SCREW, ADJUSTING
61. LOCKNUT
62. GASKET
63. ELBOW
64. ELBOW
65. ELBOW
66. BUSHING, REDUCER
67. PLUG
68. TEE, STREET
69. FITTING
70. CAPSCREW
71. WASHER
72. TEE
73. TEE, STREET

5256

Figure 2. E-10 Brake Valve

Service Check

Check the primary and secondary service circuits using test gauges known to be accurate. Test fittings are provided on the primary and secondary delivery circuits of the brake valve. Depress the pedal to several positions between the fully released and fully applied positions and check the delivered pressure on the test gauges. The pressures should vary equally and proportionally with the movement of the brake pedal.

Charge the air system to governor cut out and make a full service brake application. The primary delivery should be within 5 psi of the primary reservoir pressure. Secondary brake delivery pressure should be about 2 psi (13.8 kPa) lower than the primary delivery pressure under normal conditions. After a full application is released, the reading on the test gauge should promptly fall off to zero.

With the air system recharged to governor cut out, drain the primary reservoir and make a full service brake application. The secondary output should be within 5 psi of the secondary reservoir pressure. If the output is too low, the brake valve linkage may need adjustment.

Leakage Check

1. Coat the exhaust port and body of the brake valve with a soapy solution.
2. Make and hold a brake application to 80 psi (552 kPa).
3. Leakage permitted is a one inch (25.44 mm) bubble in three seconds.

NOTE: If the brake valve has excessive leakage, repair it and perform another leakage check.

Every 100,000 miles (161,000 km) or 12 months the brake valve should be disassembled, cleaned and inspected. Replace any parts found to be worn or damaged.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Disconnect all supply and delivery lines at the brake valve.

NOTE: Tag all air lines and their relation to the brake valve for reconnection.

3. Remove the linkage rod from the pedal to the brake valve lever.
4. Remove the mounting bolts and the brake valve.

Disassembly

1. Remove all fittings and the stop light switch (if equipped).
2. Remove the three capscrew securing the lever actuator assembly to the basic brake valve.
3. Remove the screw securing the exhaust diaphragm and washer to the exhaust cover.
4. Remove the four screws that secure the exhaust cover to the lower body.
5. Remove the secondary portion (number two) inlet and exhaust valve assembly from the lower body.
6. Unfasten and remove the four screws securing the upper body (primary portion) to the lower body (secondary portion), and separate the halves.
7. Disassemble the secondary inlet and exhaust valve assembly by removing the retaining ring. Separate the washer, O-ring retainer, both O-rings, the spring and the valve retainer.
8. Remove the four hex head capscrews securing the lower body to the upper body and separate the body halves.
9. Remove the rubber seal ring from the lower body (secondary portion).
10. Apply pressure and depress the spring seat above the primary portion (number one) piston, and remove the retaining ring.
11. Remove the spring seat and spring from the upper body (primary portion).
12. Using a 3/8 inch wrench, hold the lock nut on the threaded end of the stem in the primary portion (number one) piston. Insert a screwdriver in the exhaust passage through the center of the valve to engage the slotted head of the stem.

⚠ WARNING ⚠

The combined force of the internal springs are approximately 50 pounds (22.6 Kg). Care must be taken when removing the lock nut as the spring forces will be released. The primary portion (number one) piston and relay piston must be manually or mechanically contained while the lock nut and stem are being removed.

13. Turn wrench counterclockwise and remove the lock nut, spring seat, stem spring, primary piston, primary piston return spring and the O-ring.
14. Remove the adapter, relay piston and relay piston spring from the upper body.
15. Remove the large and small O-rings from the relay piston.
16. Remove the retaining ring securing the primary (number one) inlet and exhaust valve assembly to the upper body and remove it from the body.

17. Clean all metal parts in solvent. Dry and inspect parts for excessive wear or deterioration. Check the springs for cracks, corrosion, or for permanent set. Replace all rubber parts found to be unserviceable.

Assembly

1. Lubricate all O-rings, O-ring grooves, piston bores and metal-to-metal surfaces. Use lubrication specification S-26 (Silicon Grease - DOW CORNING 55 O-Ring Lube) as shown in Section 10 of this manual.

NOTE: The silicone grease has a temperature operating range from -65˚F to 300˚F (-54˚C to 149˚C). Silicone lubricant is not recommended for use on silicone O-rings. For reliability in cold weather operations, an alternate lubricant is recommended P/N 21-7512-11.

2. Reassemble the valve in the reverse order of the “Disassembly” procedure and torque stem and spring seat lock nut to 20-30 in-lbs. Torque valve body capscrews to 30-40 in-lbs.

3. After assembling the valve, perform a bench leakage check.

Installation

1. Mount the brake valve in reverse order of the “Removal” procedure and torque valve mounting fasteners to 40 ft-lbs.

2. Install the linkage rod and torque fasteners to their specific torque settings.

NOTE: See “Brake Pedal Assembly” for linkage fastener torques.

BRAKE PEDAL ASSEMBLY

Every 25,000 miles (40,000 km), 750 operating hours, clean any accumulated dirt, gravel and other foreign material away from the brake pedal and mounting plate. Inspect for proper “Pedal & Linkage Adjustment”. Lubricate the pedal and linkage pivots with S-6 (Light Engine Oil) as shown in Section 10.

Additionally, every 50,000 miles (80,000 km) or 1,500 operating hours all mechanical fasteners attaching the linkage rod to the brake lever arm and the rod clevis to the pedal should be inspected for proper attachment and torque.

NOTE: Torque settings may vary due to the type of fasteners used. Coaches prior to Unit 45649 (which used a standard heavy hex nut) should be torqued to 40 ft-lbs (54 N·m). Coaches produced after this unit are fitted with a stover type self-locking hex nut which requires a torque of 52.5 ft-lbs (74 N·m).

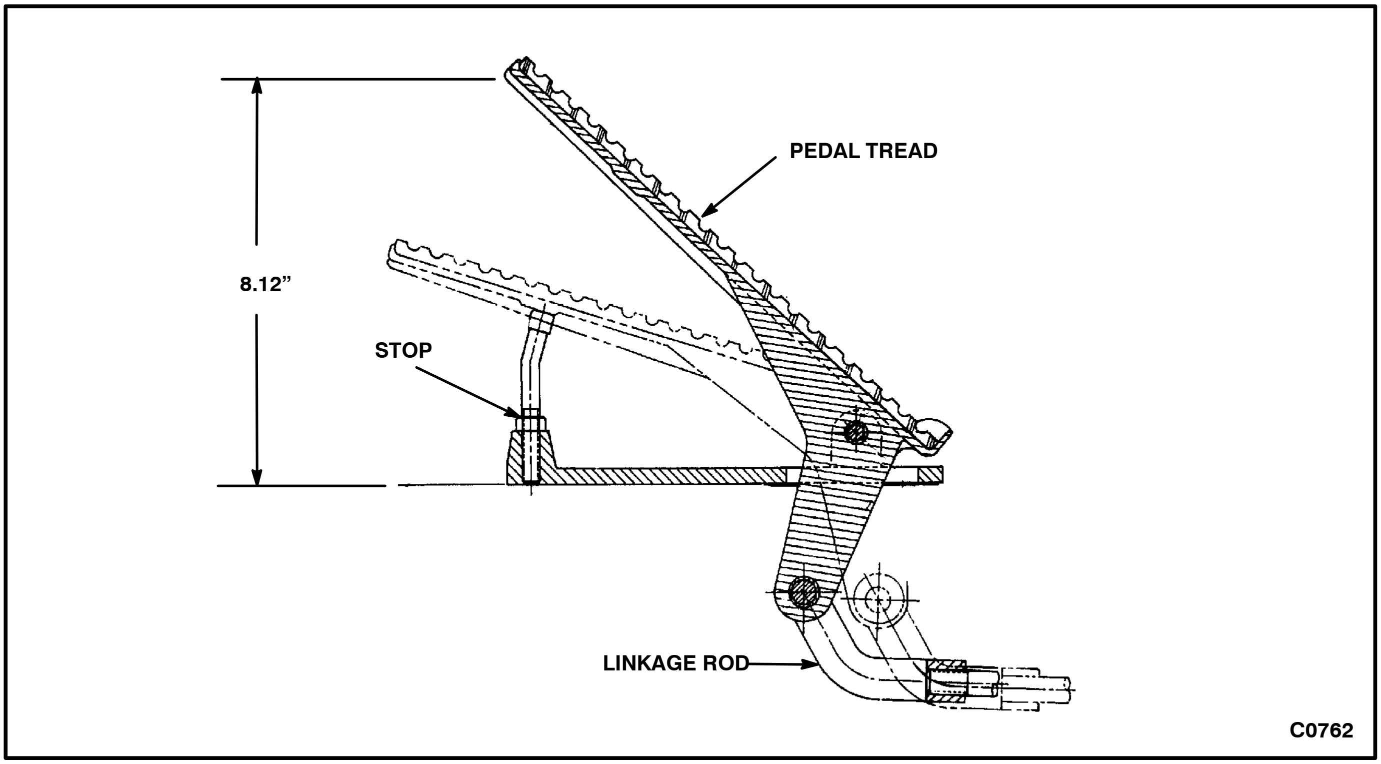


Figure 3. Brake Pedal and Linkage Assembly

Pedal & Linkage Adjustment

With brakes released, set correct pedal height (Figure 3). Hold the brake valve lever against the stop bolt on front of valve housing and measure the clearance between the brake valve plunger and the lever roller. Clearance should be 0.025-0.060 inches. Adjust pedal stop bolt and/or linkage rod to provide for this clearance.

Depress the brake pedal slowly and gradually until the inversion valve stops exhausting. Loosen locknut and set the foot pedal stop approximately 1/4 inch lower than the pedal at this point.

Attach an accurate test gauge to the test fitting on the secondary delivery circuit of the brake valve. Make a full brake application and check that delivery pressure is as stated in the previous brake valve ”Service Check” procedure.

NOTE: Adjusting the linkage rod longer will provide additional travel at the brake valve. Check that the lever will contact the stop bolt when released, and that roller does not extend past plunger when pedal is fully applied.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Remove the linkage rod from the pedal to the brake valve lever.
3. Unfasten and remove the pivot mounting bolt and pull pedal out of mounting plate slot.

Installation

1. Reinstall pedal in reverse order of the “Removal” procedure and torque pivot fasteners to 40 ft-lbs.

NOTE: The tip of the stop must also line up with the recess on the underside of the pedal.

QUICK-RELEASE VALVE

The quick release valve should have an “Operational and Leakage Test” performed every 50,000 miles (80,000 km), 1,500 operating hours (Figure 4).

Operating and Leakage Test

1. Make and hold a full brake application of approximately 80 psi (552 kPa). For QRN valves apply a 100 psi pressure.
2. Coat exhaust port with soap solution. Leakage of a one inch bubble in three seconds is permitted.
3. Coat the valve body and cover. No leakage is permitted.

NOTE: If the quick-release valve does not function properly or leaks excessively, it should be replaced or repaired as outlined below.

The quick release valve should be removed, disassembled, cleaned and inspected every 100,000 miles (161,000 km), 3,000 operating hours. Replace any parts found to be worn or damaged.

Removal

1. Place battery disconnect switch to “Off”. Block or hold vehicle by some means other than air brakes.
2. Disconnect the supply and delivery lines at the valve.
3. Unfasten mounting bolts and remove valve.

NOTE: QR-1 valves have a metal body, while the QRN valves have nylon bodies. Both types of valves may be repaired.

Disassembly

1. Unfasten the four flange screws or nuts and separate the two body halves.

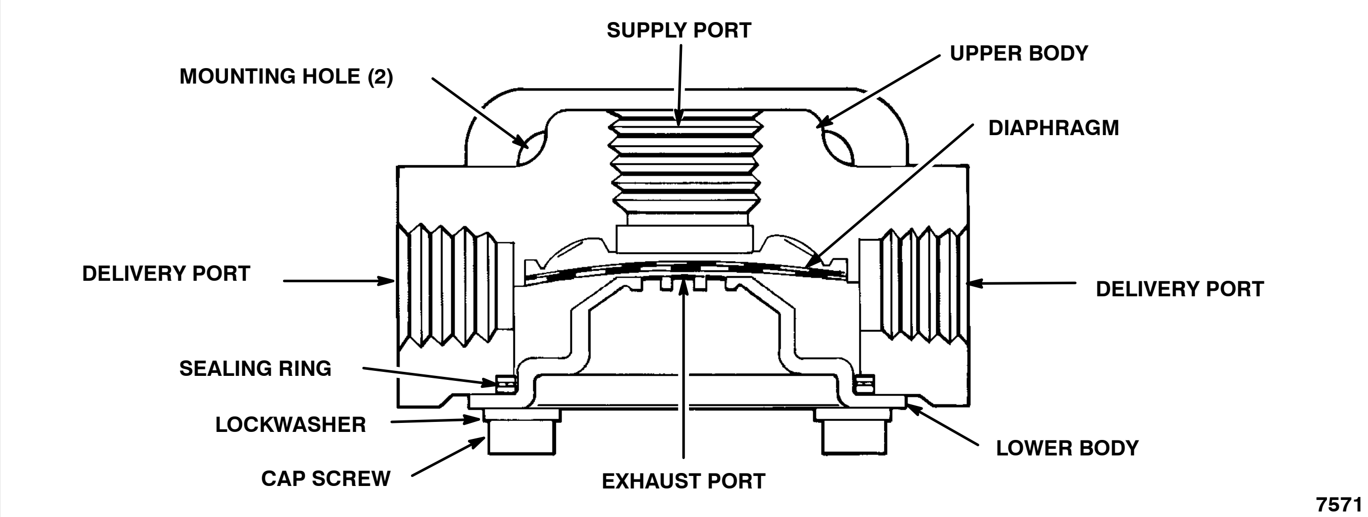


Figure 4. Quick-Release Valve

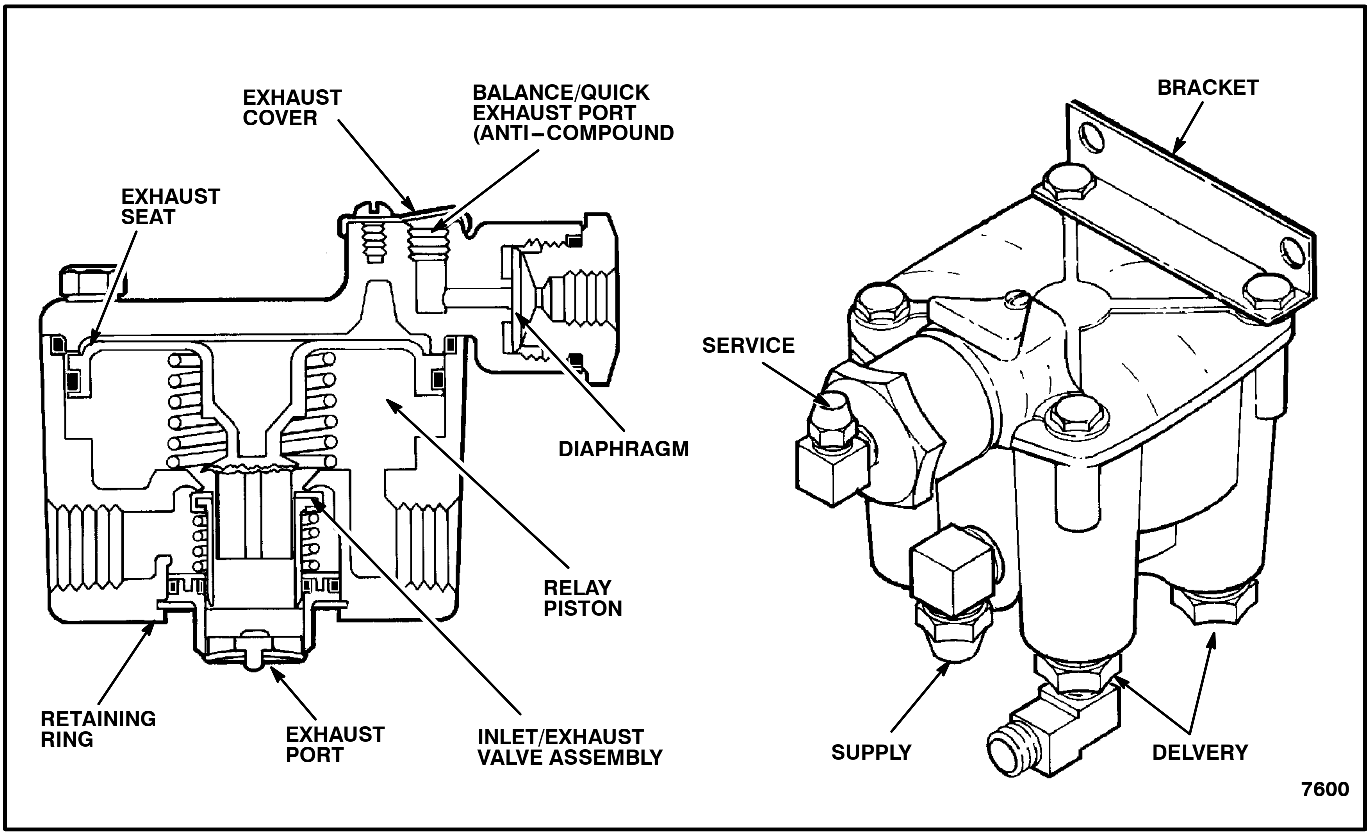


Figure 5. Service Relay Valve (R-14 shown)

2. Remove the sealing O-ring and diaphragm from between the body halves.

3. Clean all parts in cleaning solvent, and check the interior valve body halves for corrosion, pitting or nicks. Replace the valve assembly if any are found.

NOTE: It is recommended that the diaphragm and sealing ring always be replaced.

Assembly

1. Center the diaphragm in the upper body half, and position the O-ring on the lower body half.

2. Place together, install the cover fasteners and torque evenly to 60 in-lbs (6.78 N·m).

Installation

1. Install the quick release valve in the reverse order of the "Removal" procedure.

NOTE: When installing fitting to the QRN valve do not torque the supply beyond 12 ft-lbs (16.3 N·m), or the delivery over 10 ft-lbs (13.6 N·m).

RELAY VALVE

Every 25,000 miles (40,000 km) or 750 operating hours the relay valve should have an "Operational and Leakage Test" performed (Figure 5).

Operational and Leakage Test

1. Block the wheels, charge air brake system and adjust the brakes.

2. Make several brake applications and check for prompt application and release of brakes at each wheel.

3. Check for inlet valve and O-ring leakage by coating the exhaust port and area around the retaining ring with soap solution. A one inch bubble in three seconds is permitted.

NOTE: Make this check on the service relay valve with the service brakes released.

4. Check for exhaust valve leakage by coating the exhaust port and area around the retaining ring with soap solution. A one inch bubble in three seconds is permitted.

NOTE: Make this check on the service relay valve with brakes applied.

5. Apply soap solution around the valve where the cover joins the body to check for seal ring leakage. No leakage is permitted.

If the relay valve does not function properly, or if leakage is excessive, disassemble and repair.

Every 100,000 miles (161,000 km), 3,000 operating hours, disassemble, clean and inspect all parts. Install new rubber parts and replace any worn or damaged parts.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and remove all air lines from the relay valve.

NOTE: The balance port is not used with the D series dual circuit brake system, and therefore remains plugged.

3. Unfasten and remove the relay valve from the coach.

Disassembly

NOTE: Prior to disassembly, match-mark the location of the mounting bracket to the cover and the cover to the body.

1. Remove the four capscrews and lockwashers securing the cover to the body.
2. Remove the cover, sealing ring, and mounting bracket.
3. Remove the piston and O-ring from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and O-rings.
6. Remove the inlet/exhaust valve return spring from the body.
7. Remove the inlet/exhaust valve from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the phillips head screw and exhaust cover from the body cover.
10. Remove the service port capnut and O-ring.
11. Remove the diaphragm from the cover.

Cleaning and Inspection

1. Wash all parts in mineral spirits, and dry all rubber parts.

NOTE: When rebuilding, all springs and rubber parts should be replaced.

2. Inspect all parts for signs of wear and/or deterioration. Inspect springs for cracks, distortion or corrosion.
3. Inspect inlet seat and exhaust seat for nicks and burrs and replace as necessary. All rubber parts and any part showing signs of wear or deterioration should be replaced.

Assembly

Lubricate all O-rings, O-ring bores and any sliding surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) prior to assembly.

1. Install large O-ring on piston.
2. Install inner and outer O-rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the O-ring.
5. Aligning the match-marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four capscrews and lockwashers. Tighten to 80-120 in-lbs (9-14 N·m) torque.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body taking care not to damage the O-ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Install the service port cap nut O-ring on the cap nut.
12. Install the diaphragm in the cover making sure it is positioned between the guide ribs in the cover.
13. Install the port cap nut and torque to 150 in-lbs.
14. Install the exhaust port cover with the #10-24 phillips head screw. Torque to 15-25 in-lbs.
15. Test the valve as outlined in the Service Check section before returning the valve to service.

Installation

1. Clean air lines and connect them to valve.
2. Install valve and tighten mounting bolts to 20-25 ft-lbs (27-34 N·m) torque.
3. Test valve as outlined in “Operational and Leakage Tests”.

INVERSION VALVE

Every 100,000 miles (161,000 km), or 3,600 operating hours, disassemble, clean and inspect all parts. Replace all rubber parts, and any metal parts showing signs of wear or deterioration (Figure 6).

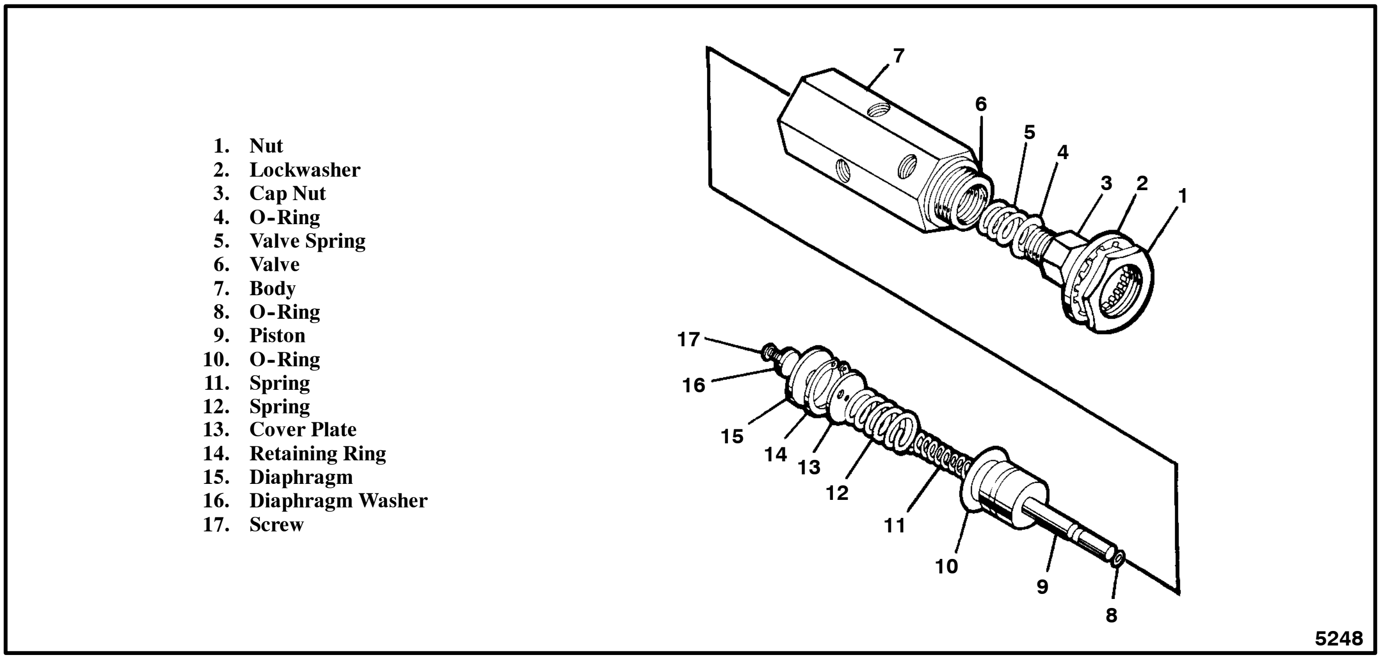


Figure 6. TR-2 Inversion Valve

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Tag and disconnect all air lines.

3. Unfasten the valve mounting nut and lockwasher from bracket, and remove the valve.

Operational and Leakage Test

1. Install a test gauge in a common control and supply line, and install another into the delivery port.

2. Gradually apply pressure to the common supply and control line. On ascending pressure, note at what pressure exhaust occurs.

3. With air pressure in supply and control ports, check for leakage by coating the supply port cap nut with soap solution. No leakage is permitted. Apply solution to the delivery and exhaust ports, a slight bubble leakage is permissible.

NOTE: Excessive leakage would indicate a faulty O-ring or inlet valve.

4. Slowly decrease pressure in the control (supply) port and note at what pressure delivery is made.

Disassembly (TR-2)

1. Remove cap nut with sealing ring, remove the ring and discard (Figure 6).

2. Remove inlet valve spring and inlet valve.

3. Turn valve over and remove exhaust diaphragm cap screw with lockwasher, then the diaphragm.

4. Remove the retainer ring, cover and both piston springs.

5. Remove piston with O-rings, remove the O-rings and discard.

Disassembly (TR-3)

1. Remove exhaust port cap nut and O-ring.

2. Remove diaphragm retainer and piston spring.

3. Remove piston with O-rings, remove the O-rings and discard.

4. Remove supply port cap nut and O-ring.

5. Remove the valve stop and spring.

6. Remove the inlet and exhaust valve.

Assembly

1. Reassemble valve in reverse order of their “Disassembly” procedures.

ANTI-LOCK VALVE

Every 25,000 miles (40,000 km), 750 operating hours, perform the following inspections (Figure 7).

1. Clean the exterior and visually inspect for excessive corrosion and/or physical damage.

2. Inspect all air lines and electrical harnesses for wear or damage.

3. Test the modulator valve as outlined in “Operational Test” and “Leakage Test”.

Leakage Test

1. Block the wheels, charge air brake system and adjust the brakes.

2. Turn engine off, make several brake applications and note that brakes apply and release properly.

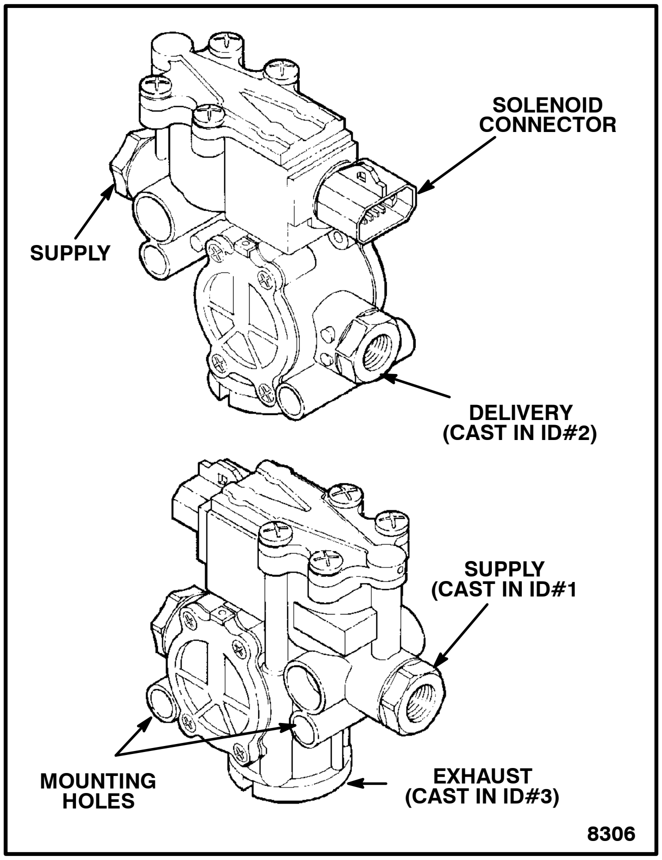


Figure 7. MC-21 Anti-Lock Modulator Valve

3. Recharge the air system and turn engine off.
4. Make and hold a full service brake application.

A. Check the exhaust port for leakage by coating the exhaust port with soap solution. A one inch bubble in three seconds is permitted.

B. Check the solenoid to valve joint for leakage by coating the joint with soap solution. A one inch bubble in three seconds is permitted

NOTE: If leakage is evident, tighten the solenoid capscrews and re-test.

C. Check the exhaust and supply diaphragm cover for leakage by coating with soap solution. A one inch bubble in three seconds is permitted.

NOTE: If leakage is evident, tighten the cover capscrews and re-test.

If the leakage is excessive, replace the M-21 modulator assembly.

Operational Test

NOTE: Two technicians will be required to perform the test.

1. Park vehicle on level surface. Block the wheels and charge air system with parking brakes released.
2. Turn ignition off, then make and hold a full brake application.
3. With brake application held, turn ignition on. The second technician stationed near the modulator should detect one or two short bursts of air from the exhaust port.

Repeat the test for each modulator on the vehicle. If no short burst of air is noted, or the exhaust is prolonged and not sharp and well defined, perform a check of the electrical portion of valve.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Remove all contaminates or dirt from valve.
3. Tag and remove all air lines, and disconnect the harness from the unit.
4. Unfasten and remove the valve from its mounting location.

NOTE: The M-21 modulator has no serviceable internal parts.

Installation

1. Reinstall the valve onto coach in reverse order of removal, and perform the “Operational” and “Leakage tests.

PRESSURE PROTECTION VALVE

Every 25,000 miles (40,000 km), or 750 operating hours Perform the operational and leakage tests.

Leakage Test

1. Block the wheels and fully charge air system before shutting engine off.
2. Apply soap solution to the valve cap. A one inch bubble in three seconds is permitted.
3. Drain air pressure from the delivery side of valve, disconnect the delivery ports line and apply soap solution to the delivery port. A one inch bubble in five seconds is permitted.

If the leakage is excessive, around the cap and delivery port, repair or replace the assembly.

Operational Test

1. Install a pressure gauge and drain valve on the supply and delivery sides of the valve.
2. Build system air pressure and turn engine off.

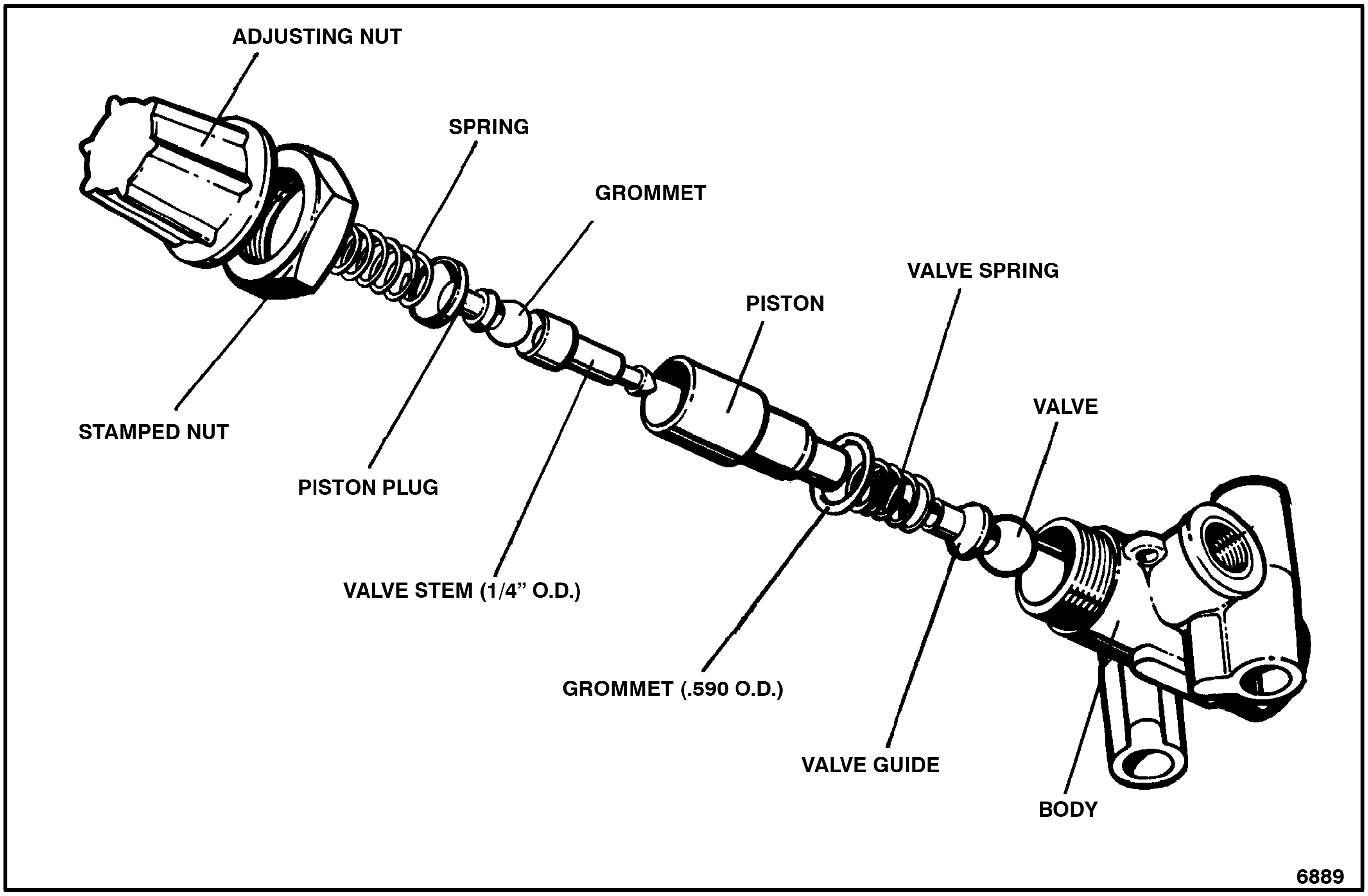


Figure 8. Pressure Protection Valve

3. While watching the gauges on both sides, slowly exhaust air from the delivery side of valve until valve closing pressure is reached. Both sides should show pressure loss until the the closing pressure of the valve is reached. Closing pressures should be noted on valve.

NOTE: Effective with unit 48314, the main pressure protection valve (located in the central heat compartment) was changed. The old valve was set to close at 65 psi and re-open at 75-80 psi. The new valve is set to close at 80 psi and re-open at 95 psi.

Every 100,000 miles (161,000 km), or 3600 operating hours disassemble, clean and inspect all parts. Replace all rubber parts, and any metal parts showing signs of wear or deterioration (Figure 8).

Removal

1. Place battery disconnect switch "Off". Block vehicle and vent the entire air system.
2. Tag and remove all air lines from the valve.
3. Unfasten and remove the valve from the coach.

Disassembly

1. Loosen locknut from knob and unscrew adjust knob, then remove locknut.
2. Remove spring, piston, piston plug and inlet valve from body.
3. Remove inlet valve from stem, spring retainer and inlet valve spring.
4. Turn piston over and depress the inlet valve stem fully and remove the O-ring.
5. Clean and inspect all rubber parts and springs for wear.

Assembly

Lubricate all O-rings, O-ring bores and all sliding surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) prior to assembly.

1. Reinstall inlet valve stem into piston.
2. Install small O-ring on piston plug and install piston plug pressing snugly into piston body.
3. Install inlet valve spring, spring retainer and snap on the rubber inlet valve.

4. Install inlet valve spring, spring retainer and snap on the rubber inlet valve.

5. Install O-ring onto piston end and insert into body.

6. Replace spring and install adjust knob locknut.

7. Replace adjusting knob and readjust the valve before tightening locknut to knob.

Installation

1. Reinstall pressure protection valve in reverse order of the "Removal" procedure.

RESERVOIRS

Air compressors pass a certain amount of oil and water into the reservoir in the form of vapor during compression. After reaching the reservoir, the vapor cools and condenses in the form of an oil and water emulsion. Reservoirs incorporate a pull type drain cock at tank bottom, and should be drained frequently. In addition to periodic draining, the reservoirs should be checked for mounting integrity and for outer surface corrosion or damaged lines and fittings (Figure 9).

NOTE: An additional air tank is installed in the engine compartment near the right rear wheelhousing for the 102DL3 rear rise feature.

Removal

1. Place battery disconnect switch "Off". Block vehicle and vent the entire air system.

2. Tag and remove all air lines from the reservoir to be removed.

3. Unfasten and the support straps and remove from coach.

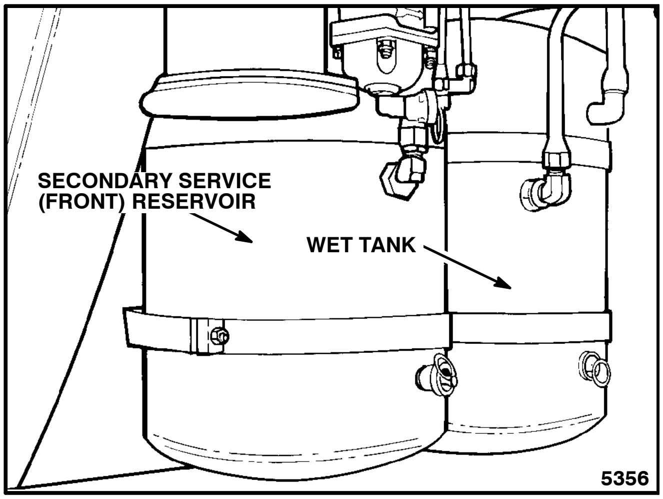


Figure 9 . Air System Reservoirs

Installation

1. Reinstall reservoir in reverse order of the "Removal" procedure.

DOUBLE CHECK VALVE

Every 25,000 miles (40,000 km), or 750 operating hours, perform the "Operational and Leakage Test". Depending upon the installation, it may be necessary to completely remove the check valve so that the following checks may be made.

Operational and Leakage Test

1. Disconnect the emergence park supply line from the emergency stand-by valve (port opposite of inversion valve delivery port).

2. Make a normal park brake application and apply air pressure through to the delivery port.

3. Coat the open end of the check valve with soap solution. A one inch bubble in five seconds is permitted.

Every 100,000 miles (161,000 km), or 3600 operating hours, disassemble, clean and inspect all parts. Replace all rubber parts, and any metal parts showing signs of wear or deterioration.

Removal

1. Place battery disconnect switch to "Off". Block vehicle and vent the entire air system.

2. Tag and remove all air lines from the double check valve.

3. Unfasten and remove check valve from mounting location.

Disassembly

1. Unfasten the two capscrews and remove check valve cap.

2. Remove the shuttle and the shuttle guides from the valve body.

Assembly

1. Install the shuttle guides and the shuttle into the valve body.

2. Place cap and body together and torque fasteners to 60 in-lbs (6.78 N·m).

Installation

1. Reinstall check valve in reverse order of "Removal" procedure and test.

When installing valve, make certain that it is installed correctly with respect to the desired air flow. An arrow indicating the direction of air flow should be cast into the valve body.

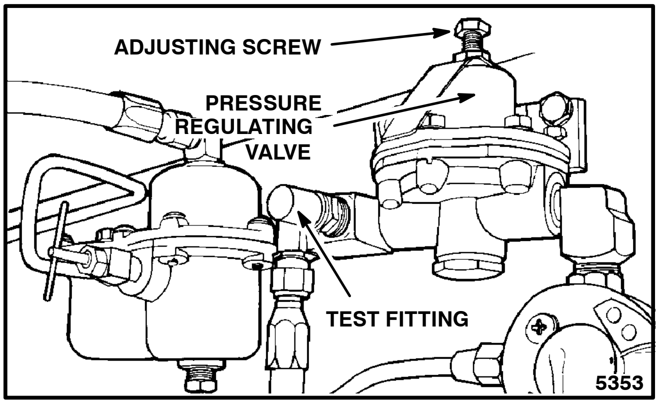


Figure 10. Pressure Regulator Valve

PRESSURE REGULATOR

Every 50,000 miles (80,000 km) or 1,500 operating hours, the regulator valves should be checked and reset to their proper set pressures. Listed below are the pressure regulating valves that are used and the pressures to which they are to be set:

1.	A/C BELT TENSION	95 psi (655 kPa)
2.	PARK BRAKE	85 psi (586 kPa)
3.	TAG AXLE BRAKES	21 psi (145 kPa)
4.	TAG AXLE UNLOADING	15 psi (103 kPa)
5.	TAG AXLE LOADING	35 psi (241 kPa)
6.	LAVATORY DOOR	21 psi (145 kPa)
7.	TRANS MODULATOR	70 psi (482 kPa)
8.	LAVATORY AIR FLUSH	11 psi (76 kPa)

Every 100,000 miles (161,000 km) or 3,000 operating hours, the regulator valves should be removed, disassembled and cleaned. Replace the diaphragm and any damaged parts (Figure 10).

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Disconnect the pressure regulating valves air lines.

3. Unfasten the mounting bolts and remove the valve.

Disassembly

1. Unfasten the six screw and separate the two body halves.

2. Separate the valve halves and remove the diaphragm(s), springs and spring retainers.

3. Unfasten the bottom cover and remove the poppet and spring.

Cleaning and Inspection

1. Wash all metal parts in cleaning solvent.

2. Inspect inside of valve for water or damage. If the valve is excessively grooved or pitted, it should be replaced.

Testing

1. Install a tee fitting and plug in the outlet port of the pressure regulating valve. This enables installation of a test gauge for adjusting or checking the pressure regulating valve setting.

2. Loosen the locknut, turn the adjusting screw counterclockwise to reduce the pressure approximately 10 psi (69 kPa) below the pressure required.

3. Turn the adjusting screw clockwise to increase the pressure slowly until the required pressure setting is reached, then tighten the locknut.

4. Test the valve for any leakage by applying a soap solution while pressurized.

Assembly

1. Reassemble valve in reverse order of “Disassembly” procedure.

2. After valve is assembled check the pressure setting using the previous test procedure and adjust the valve to the specific pressure setting.

Installation

1. Reinstall regulator in reverse order of “Removal” procedure.

AIR HORNS AND VALVE

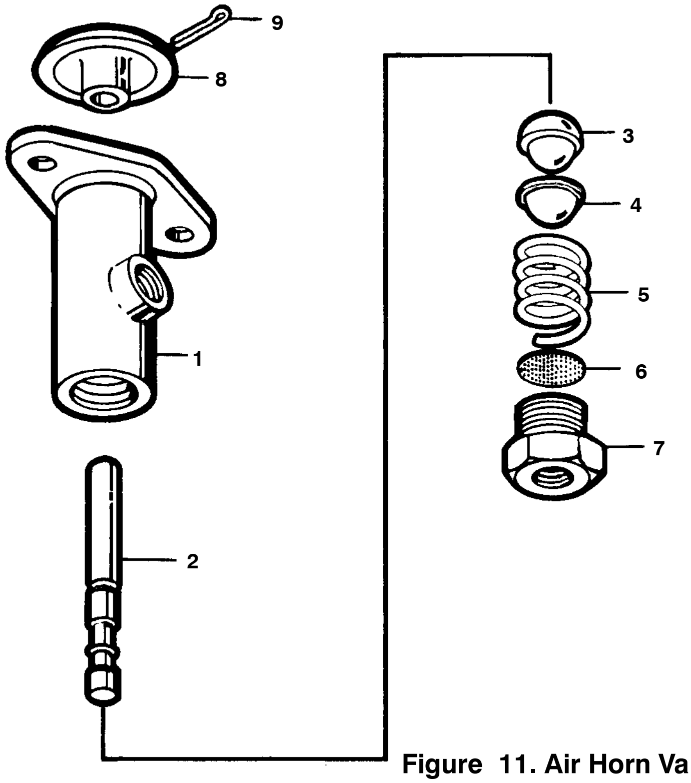
Every 10,000 miles (16,000 km), remove the strainer in the bottom of horn valve and clean thoroughly with cleaning solvent. Remove dirt screens in the horn bells and clean (Figure 11 12).

Operating Test

With air pressure in the system, operate the horn valve and the horn should give a loud, clear dual-tone report.

Leakage Test

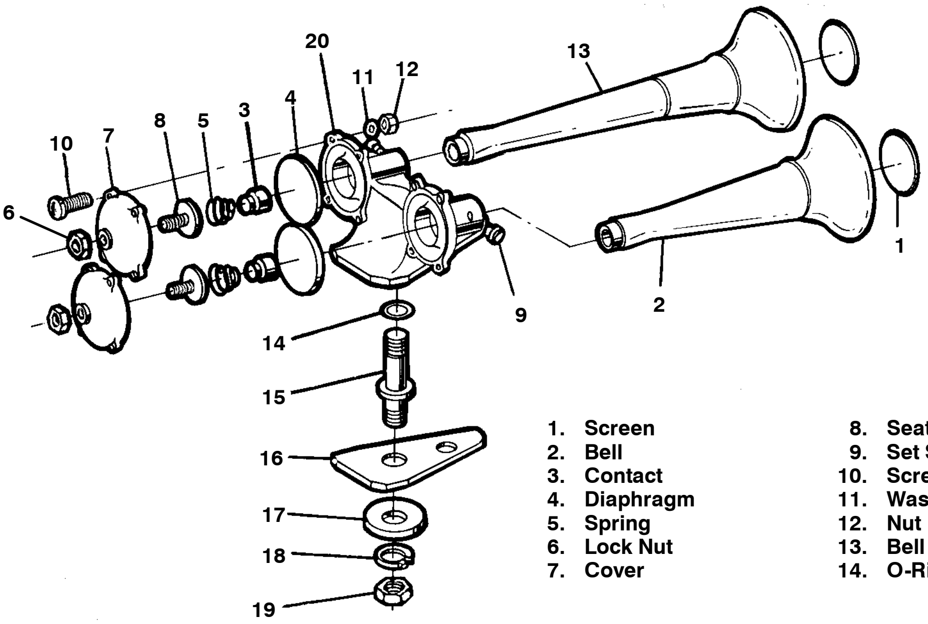
With the horn valve in the released position, leakage at the delivery port or at the valve stem at the top of the horn valve should not exceed a one-inch (25.4 mm) soap bubble in one second. With the horn valve applied, leakage at the stem at the top of the horn valve should not exceed a one inch bubble in one second.



1. Body
2. Stem
3. Inlet Valve
4. Spring Seat
5. Spring
6. Strainer
7. Cap - !@4 NPT
8. Button
9. Cotter Pin

Figure 11. Air Horn Valve

5275



1. Screen
2. Bell
3. Contact
4. Diaphragm
5. Spring
6. Lock Nut
7. Cover
8. Seat-Spring
9. Set Screw
10. Screw
11. Washer
12. Nut
13. Bell
14. O-Ring
15. Coupling
16. Gasket
17. Washer
18. Washer
19. Nut
20. Body

5274

Figure 12. Air Horns

Removal (Horn)

1. Disconnect the air line to the air horn. Remove air horn mounting nut and remove horn.

2. Remove the eight nuts and bolts holding the two covers to the body.

3. Remove the diaphragms from the body of horn.

4. Remove the spring contact, springs, and the spring assemblies from the covers of the air horn.

5. Remove the horn bells from the body.

Removal (Valve)

1. Vent the air system. Disconnect air lines to the horn valve. Remove mounting bolts and remove the horn valve.

2. Remove the spring seat from the valve body.

3. Remove the valve stem from the valve body.

4. Remove the strainer and spring from the spring seat.

Inspection

1. Inspect air horn supply valve and seat. If damaged, they should be repaired or replaced.

2. Wash all air horn metal parts in cleaning solvent.

3. Carefully inspect the diaphragms to be sure they are not cracked, deteriorated, or distorted in any way. If ridges or cracks are found, the diaphragms must be replaced.

4. Inspect condition of the body. Be sure diaphragm seat in body is not chipped or damaged in any way. Check for cracks in the body and replace as necessary.

5. Inspect the covers. Be sure diaphragm seat in cover is not chipped or damaged. Inspect the cover for cracks.

6. Inspect the horn bells. If they are cracked or broken, they should be replaced.

7. Inspect the spring and contacts. Replace if distorted, deteriorated or broken.

Installation

1. Reinstall horn and valve in reverse order of removal procedure.

BRAKE LIGHT SWITCH

Every 100,000 miles (161,000 km) or 3,000 operating hours inspect the operation of the low air pressure switch.

Testing

Apply the brake valve and note that with the first downward movement of the brake valve pedal or treadle, the stop light immediately lights. Release the brake valve and note that the stop light goes off. With the brake applied, no leakage is permitted at switch.

Removal

1. Place battery disconnect switch “Off”, block vehicle and vent the service and park brake air circuits.

2. Disconnect electrical harness and air line connections (Figure 13).

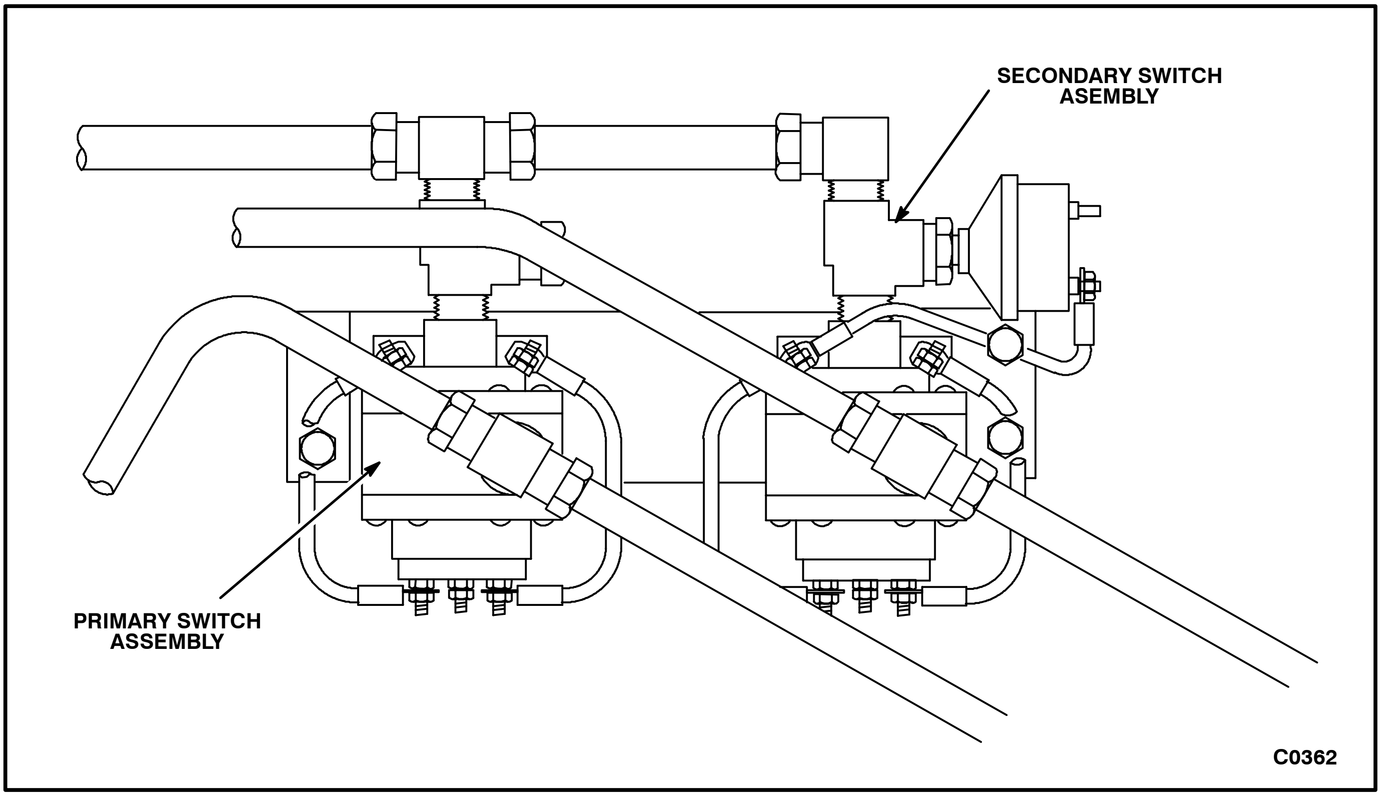


Figure 13. Brake Light Switch Assembly

3. Unfasten the mounting capscrews and remove switch.

Installation

1. Reinstall switch in reverse order of “Removal” procedure and torque mounting fasteners to 20 ft-lbs.

NOTE: There are no serviceable parts in the low pressure and brake light switches.

LOW AIR PRESSURE SWITCH

Every 100,000 miles (161,000 km) or 3,000 operating hours inspect the operation of the low air pressure switch. The switches monitor air pressures at the rear air/fuel junction block and directly from the wet tank.

NOTE: Effective with 48314 the low air switch plumbed from the wet tank will be removed. Two switches will be installed on the rear supply ports of the brake valve.

Testing

The switch may be checked by reducing the reservoir pressure through application and release of the service brakes numerous times. The telltale warning light and buzzer should come on when the air pressure gauge drops below 75±5 psi (517±34.5 kPa).

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Disconnect electrical harness and remove switch from air line connection.

Installation

1. Reinstall switch in reverse order of “Removal” procedure.

AIR FILTER

Every 50,000 miles (80,000 km) or 1,500 operating hours the filter should be disassembled, cleaned and inspected. The element and cover gasket should also be replaced (Figure 14).

CAUTION

Failure to service the air filters at regular intervals may affect the operation of other components (i.e., leveling control valves, retracting step control and main hot water valve).

NOTE: It is recommended that all of the filters be serviced at the beginning of winter to prevent freeze damage.

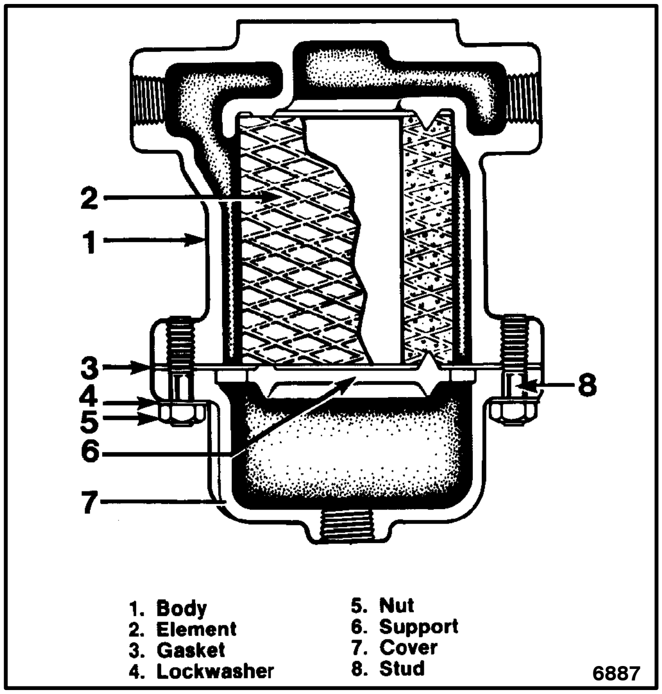


Figure 14. Type “E” Air Filter

Removal (Bendix)

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Manually actuate the condensate/air drain.

3. Tag and disconnect all air lines and fittings.

4. Unfasten the filter mounting capscrews and lockwasher from bracket, and remove the filter.

Removal (Norgren)

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Open the cover panel in stepwell area for step control filter, or the HVAC blower door for water valve filter.

3. Manually actuate the condensate/air drain.

4. Tag and disconnect all air lines and fitting.

5. Unfasten the filter mounting screws, washers and lockwashers from bracket, and remove the filter.

NOTE: The Bendix or Norgren filters do not require removal for element servicing.

Disassembly (Bendix)

1. Unfasten the two capscrews and separate the two body halves.

2. Remove the spring, filter element and gasket.

3. Clean and inspect the inside of filter body for excessive corrosion or blockage.

Disassembly (Norgren)

1. Twist the bowl and separate from the filter head.
2. Remove the O-ring, louver, filter element and gasket.
3. Clean and inspect the inside of filter bowl for excessive corrosion or blockage.

Assembly

1. Install new element and gasket and reassemble valve in reverse order of their “Disassembly” procedure. Torque body capscrews to 20 ft-lbs.

Installation

1. Reinstall switch in reverse order of “Removal” procedure and torque mounting fasteners to 30 ft-lbs.

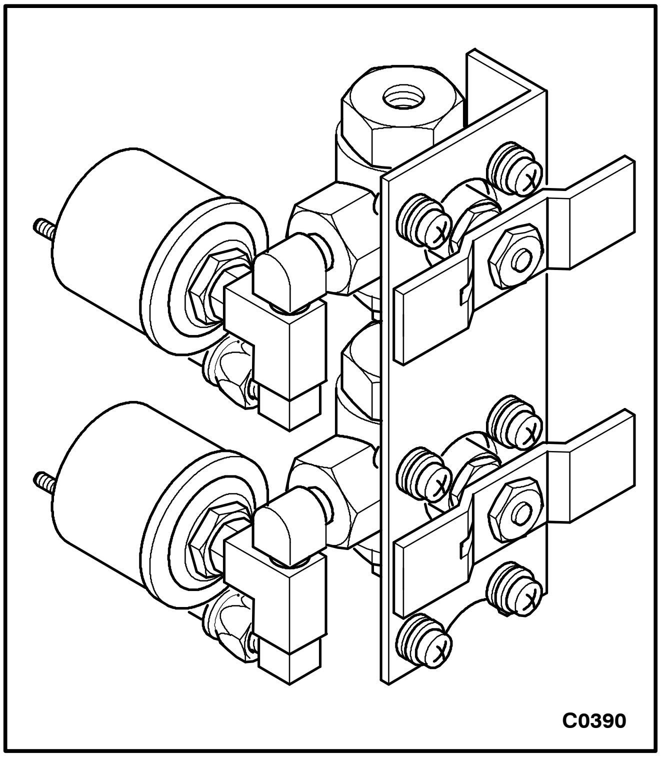


Figure 15. Tag Axle Unloading Valve

TRAILING AXLE UNLOADING VALVES

Every 50,000 miles (80,000 km) or 1,500 operating hours the unloading valves should have an “Operational and Leakage Test“ performed (Figure 15).

Operating Test

With air pressure in the trailing suspension system, operate the valves to dump and then refill the suspension bellows. Also, check the function of the low tag bellows warning light switch.

Leakage Test

With the valves in the fill position, apply soap solution to them. Leakage at the exhaust port or at the valve stem should not exceed a one inch bubble in five second.

NOTE: If excessive leakage is detected while being tested, remove and replace the valve.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and disconnect all air lines and fittings, and remove the wire harnesses from the switches.
3. Unfasten the valve handle hex nut and remove.
4. Unfasten the valve mounting screws and remove valve from bracket.

Installation

1. Reinstall switch in reverse order of “Removal” procedure and torque mounting fasteners to 20 ft-lbs.

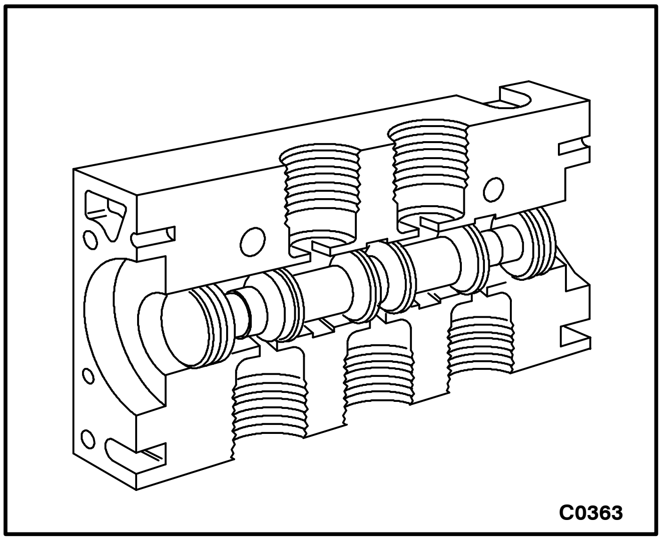


Figure 16. Caster Control Valve

TRAILING AXLE CASTER CONTROL VALVE

Every 50,000 miles (80,000 km) or 1,500 operating hours the control valves should be lubricated (Figure 16). Lubricate the spool and valve bore surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) applied through the air lines.

NOTE: There are no periodic maintenance requirements for the Norgren control valves other than lubrication.

Lubrication

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Disconnect air lines from the manifold and valve.
3. Apply two drops of lubricant to each port and reconnect.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Tag and disconnect all air lines and fittings, and remove the wire harnesses from the switches.

3. Unfasten the valve mounting screws and remove the valve from the manifold.

Disassembly

1. Unfasten the solenoid mounting screws and remove the solenoid assembly, seal and piston.

2. Unfasten the return cap mounting screws and remove the cap body, seal, spring and spacer.

3. Push spool out of valve, and remove the O-ring seals.

Assembly

1. Reassemble valve in reverse order of “Disassembly” procedure and torque mounting fasteners to 12 ft-lbs.

Installation

1. Reinstall valve in reverse order of “Removal” procedure and torque mounting fasteners to 20 ft-lbs.

SPECIFICATIONS

BRAKE VALVE

Part Number (Model E10)	4G-15-33
Part Number (Model E15)	4L-15-127
Part Number (Model E10-R)	4L-15-112
Part Number (Model E15-R)	4L-15-128
Vendor	Bendix

PARKING BRAKE VALVE

Part Number	4B-28-1
Vendor	Bendix
Model	PP-2

SERVICE RELAY VALVE

Part Number (R-14)	4L-11-11
Part Number (R-12)	4G-11-1
Make	Bendix
Crack Pressure	4 psi

QUICK RELEASE VALVE

Part Number (Model QR-1)	4L-22-97
Part Number (Model QRN)	4L-12-1
Make	Bendix

SYNCHRO VALVE

Part Number	4L-28-15
Make	Bendix
Model	SV-1
Crack Pressure	psi

ANTI-LOCK MODULATOR VALVE

Part Number	4L-22-91
Make	Bendix
Model	MC-21

PRESSURE PROTECTION VALVE

Part Number (Used Prior to 48314)	12C-7-16
Part Number (Effective with 48314)	4L-22-256
Vendor	Bendix
Model	PR-2

EMERGENCY STAND-BY VALVE

Part Number	4L-22-85
Vendor	Bendix
Model	TR-2

INVERSION VALVE

Part Number (Rear Brakes Model TR-2)	4L-29-2
Part Number (Radiator Fan Clutch and Shutter Control Model TR-3)	4L-29-3
Vendor	Bendix

STOP LIGHT SWITCHES

Part Number (Preliminary)	4L-13-53
Part Number (Secondary)	4L-13-55
Vendor	Williams

AIR FILTER

Part Number	4F-7-3
Vendor	Bendix
Model	Type-“E”

SECTION 4E

AIR COMPRESSOR AND GOVERNOR

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

The Tu-Flo® 750 air compressor (Figure 1) is a two cylinder, single stage, reciprocating compressor with a rated displacement of 16.5 CFM at 1250 RPM. The compressor is mounted to and driven directly by the engine front auxiliary drive. The compressor is water cooled, and filtered air from either the engine intake air cleaner or intake manifold flows to the compressor through a separate intake tube or hose.

The compressor provides and automatically maintains air pressure to the air dryer through governor controlled loading and unloading. The air compressor operates continuously while the engine runs, but actual compression is controlled by the intake valve unloader piston mechanism. The unloaders are actuated by governor control air.

The governor operates in conjunction with the air compressor inlet valve unloader mechanism to automatically provide pressurized air to the dryer and the entire air system. Predetermined maximum (unload) and minimum (load-up) set pressures are adjustable. The governors are mounted to the air compressor on all engine installations.

NOTE: The air compressor and governor work in conjunction with the air dryer to keep system pressure maintained. The air dryer control port is pressurized by the governor.

COMPONENTS

The compressor assembly consists of two major subassemblies: the cylinder head and the crankcase.

CYLINDER HEAD

The cylinder head is an iron casting which houses the intake, discharge, and intake unloader valving. The cylinder head is bolted to the compressor housing. The cylinder head provides for reservoir, unloader and exhaust port mounting to the governor. The coolant water inlet port is connected to the engine block, and the coolant return is connected to the engine cylinder head. The air intake port is connected to the intake air tube or hose from either the filter or manifold. The discharge port is connected to the discharge air line (Figure 2).

CRANKCASE

The crankcase houses the cylinder bores, pistons, crankshaft and main bearings, and provides the flange or base mounting surface. A nameplate identifying the compressor piece number and serial number is attached to the side of the crankcase.

NOTE: The crankcase drive housings may differ from one engine installation to another.

GOVERNOR

The governor main component is the piston and the pressure setting screw and spring. The governor housing mounts to the compressor and provides for reservoir, unloader and exhaust ports (Figure 3). The reservoir port is connected to the rear air/fuel junction block. The unloader port is connected to the dryer control port, and the exhaust is open.

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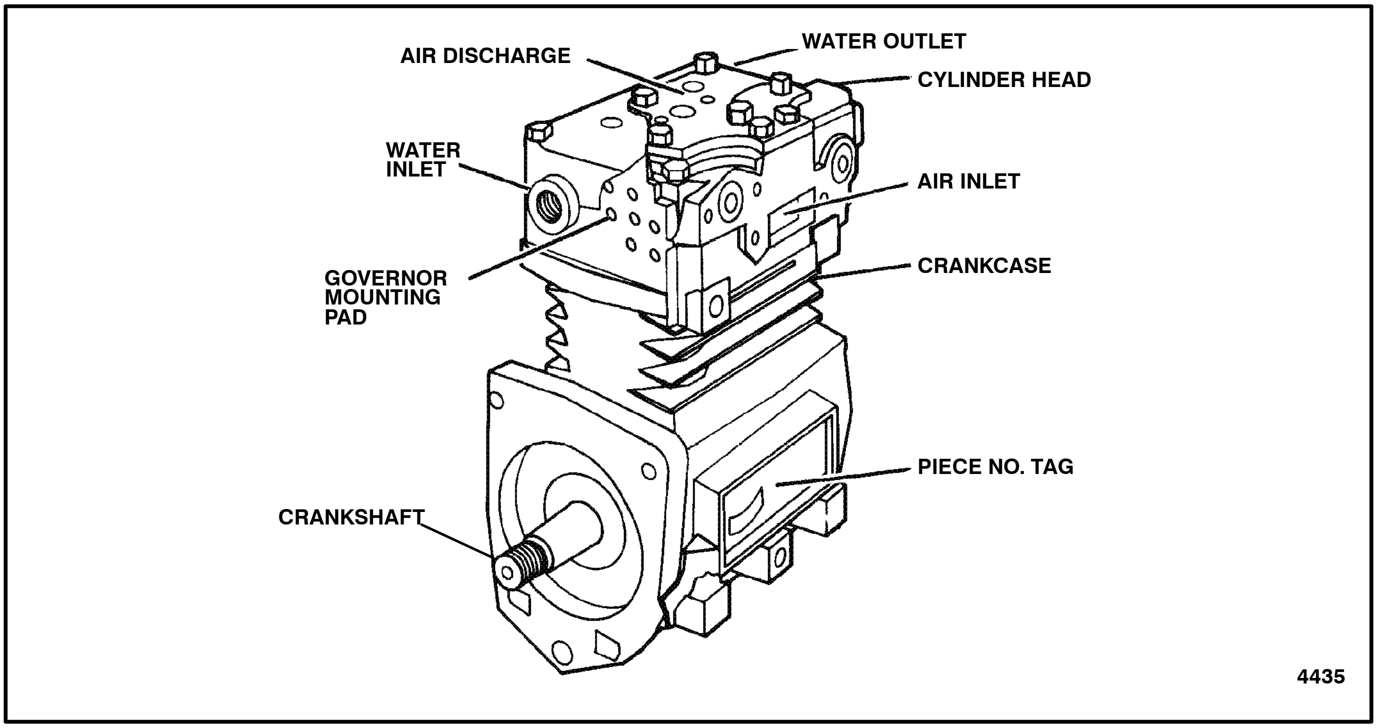

AIR DISCHARGE
WATER OUTLET
CYLINDER HEAD
WATER INLET
AIR INLET
GOVERNOR MOUNTING PAD
CRANKCASE
PIECE NO. TAG
CRANKSHAFT
4435

Figure 1. Bendix Tu-Flo 750® Air Compressor

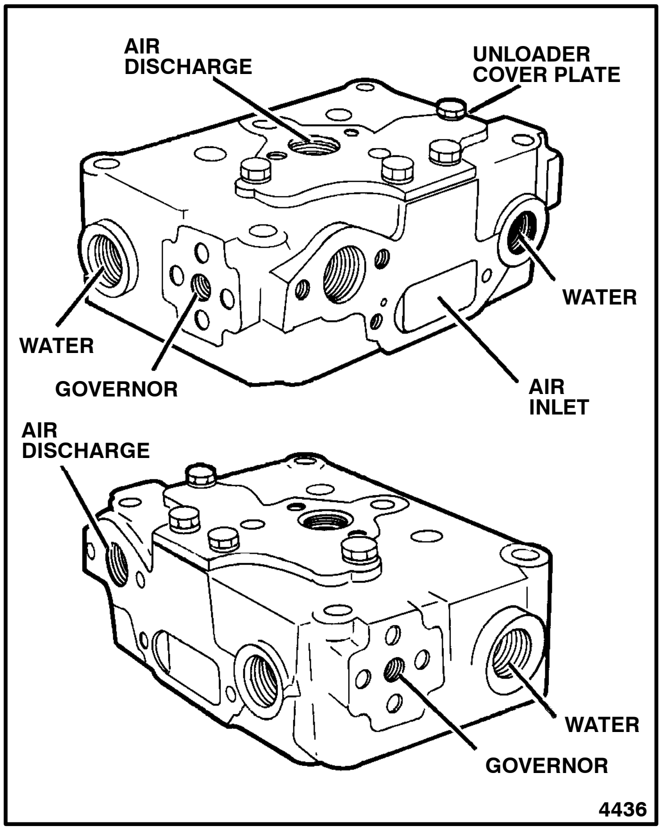

AIR DISCHARGE
UNLOADER COVER PLATE
WATER
WATER
GOVERNOR
AIR INLET
AIR DISCHARGE
WATER
GOVERNOR
4436

Figure 2. Cylinder Head

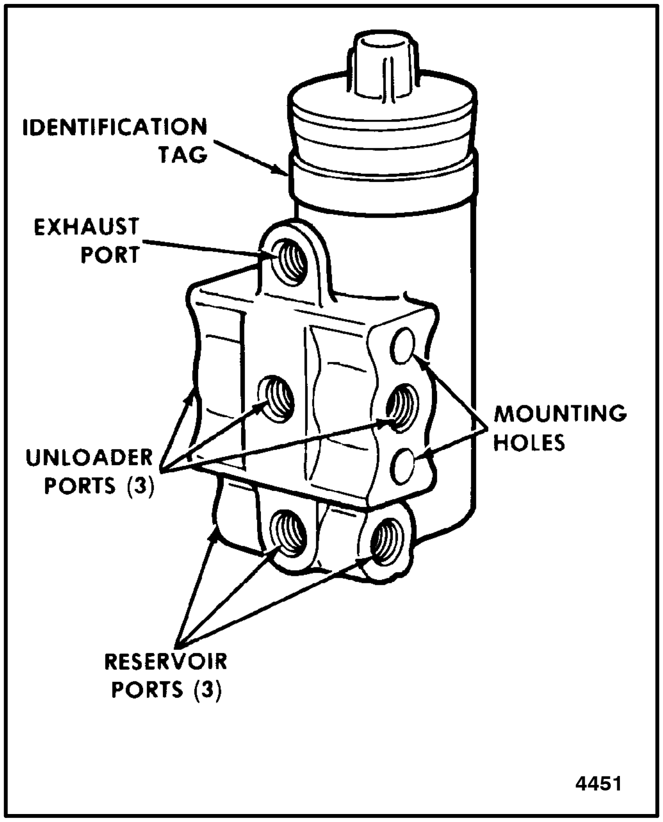

IDENTIFICATION TAG
EXHAUST PORT
MOUNTING HOLES
UNLOADER PORTS (3)
RESERVOIR PORTS (3)
4451

Figure 3. Type “D-2” Governor Ports

OPERATION

COMPRESSOR

Loaded

During the down stroke of the piston, a slight vacuum is created between the top of the piston and the cylinder head, causing the inlet valve to move off its seat and open. Air is drawn through the air strainer and open valve into the cylinder. The discharge valve remains on its seat during intake valve operation (Figure 4).

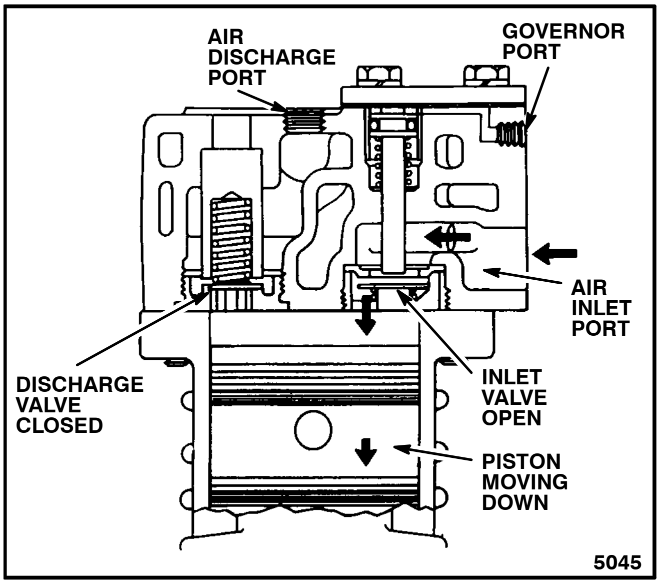

AIR DISCHARGE PORT
GOVERNOR PORT
AIR INLET PORT
DISCHARGE VALVE CLOSED
INLET VALVE OPEN
PISTON MOVING DOWN
5045

Figure 4. Operation - Loaded (Intake)

As the piston begins its upward stroke, the inlet valve is seated to allow air that was drawn into the cylinder to be compressed. The piston continues the upward stroke and compressed air pushes the discharge valve open, as compressed air escapes into the inlet valve of the second stage or the discharge line (Figure 5).

As the piston reaches the top of its stroke and starts down, the discharge valve spring and air pressure in the discharge line returns the discharge valve to its seat. This prevents the compressed air in the discharge line from returning to the cylinder bore as the intake and compression cycle is repeated

NOTE: During loaded operations the governor exhaust port is open to the unloader port, thereby exhausting air from the unloader mechanism and the dryer control line.

Unloaded

When air pressure in the reservoir reaches the cut-out setting of the governor, air is allowed to pass from the reservoir port through the governor and into the cavity above the unloader pistons.

The unloader pistons move down holding the inlet valves off their seats during compression stroke (Figure 6). With the inlet valves held off their seats by the unloader pistons, air is pumped back and forth between the two cylinders, and the discharge valves remain closed.

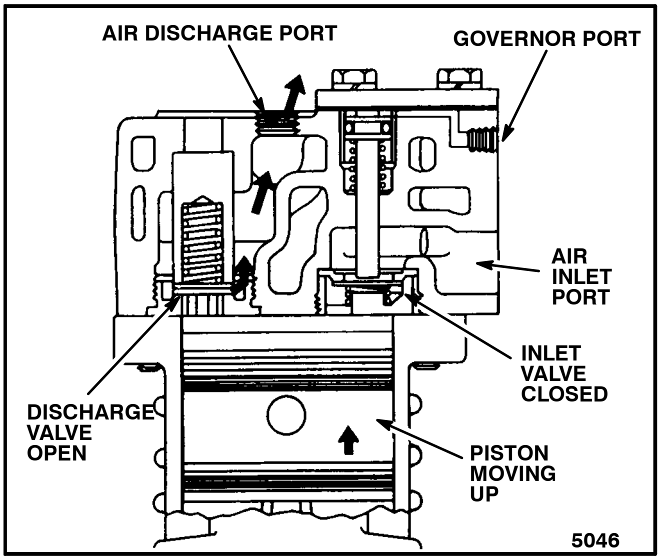

AIR DISCHARGE PORT
GOVERNOR PORT
AIR INLET PORT
INLET VALVE CLOSED
DISCHARGE VALVE OPEN
PISTON MOVING UP
5046

Figure 5. Operation - Loaded (Compression)

When air pressure from the reservoir drops to the cut-in setting of the governor, the governor closes and exhausts the air from above the unloader pistons. The unloader springs force the pistons upward and the inlet valves return to their seats during compression stroke.

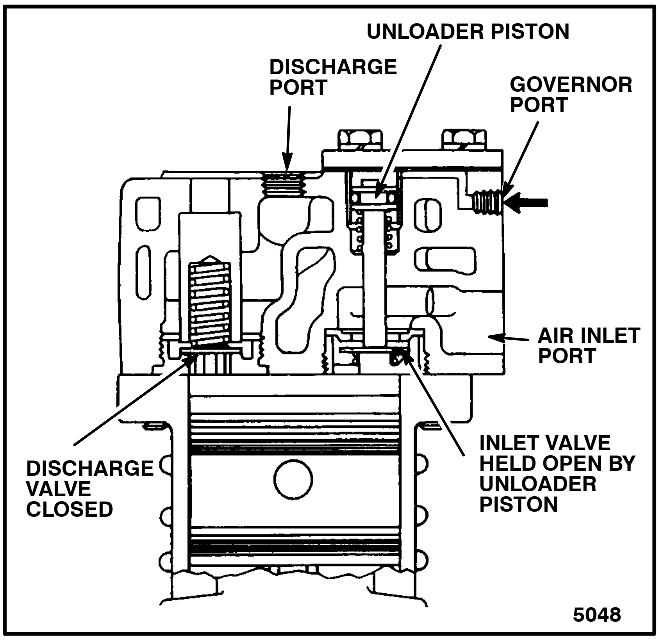

UNLOADER PISTON
DISCHARGE PORT
GOVERNOR PORT
AIR INLET PORT
INLET VALVE HELD OPEN BY UNLOADER PISTON
DISCHARGE VALVE CLOSED
5048

Figure 6. Operation - Unloaded

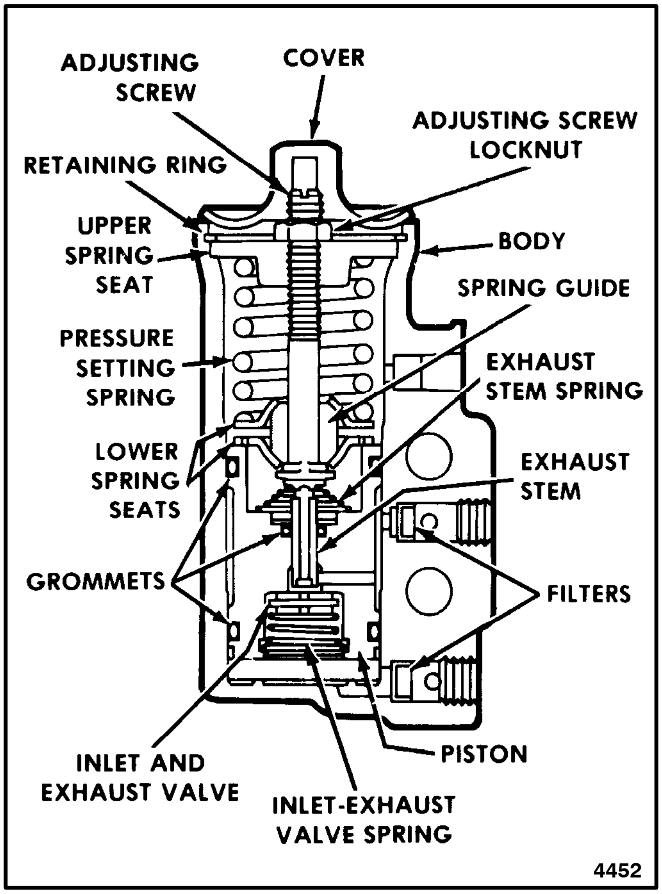


Figure 7. Type D-2 Governor

GOVERNOR

Load-Up

As the system air pressure drops to the cut-in set pressure of the governor, reduced air pressure against the piston allows the spring tension to move the piston down. The exhaust stem is moved off its seat and opens, while the inlet valve closes. With the exhaust open, the air in the unloader control line and unloader mechanism will escape back through the piston through the exhaust stem and out the exhaust port.

NOTE: During loaded operations the dryer control line is exhausted, allowing the turbo cutoff piston to open the supply port of the dryer.

Unload

As system air pressure increases, it enters the governor at one of the reservoir ports. Air pressure acting on the governor control piston moves the piston up and overcomes the pressure setting spring tension. As pressure continues to build and reaches the cut-out setting, the exhaust stem (through contact with the adjustable set screw) seats on the inlet/exhaust valve, closing the exhaust passage and opens the inlet valve.

System air pressure flows around the open inlet valve through the piston passage and out the unloader port to the compressor unloading mechanism. Air also flows around the center of piston, which has a slightly larger upper end. The added force resulting from this larger area assures a positive action and fully opens the inlet valve (Figure 7).

NOTE: While unloaded, the unloader port pressurizes the control line to the air dryer. This causes the turbo-cutoff piston to block the supply (discharge line) inlet port and purge the dryer.

INSPECTIONS & TESTING

Compressor Lubrication

The coach engine provides a continuous supply of oil to the compressor. Oil is routed from the engine to the compressor oil inlet. An oil passage in the compressor crankshaft allows oil to lubricate the connecting rod crankshaft bearings (Figure 8). Connecting rod wrist pin bushings and crankshaft ball bearings are spray lubricated. The oil drains back directly to the engine through the mounting flange.

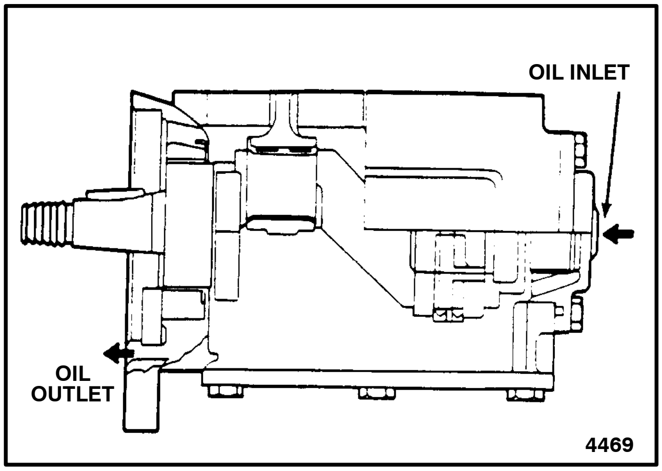


Figure 8. Lubrication

NOTE: The intervals listed pertain to typical highway and street operations. More frequent maintenance will be required for operation in dusty or dirty environments.

Every 50,000 miles (80,000 km) or 1,500 operating hours an inspection for kinks, bends, or restrictions to flow in all external oil supply and return lines should be made. Supply lines must be a minimum of 3/16 inch I.D. and return lines must be a minimum of 1/2 inch I.D. Oil return lines should slope as sharply as possible back to the engine crankcase and should have as few fittings and bends as possible. Refer to the tabulated technical data in the back of this section for oil pressure minimum values.

Compressor Air Intake

Every 5,000 miles (8,000 km) or 150 operating hours or when the engine intake air filter is changed, the compressor intake tube and adapters should be checked. Check the tube for deterioration or damage and check the clamps to be sure they are secure. Inspect both adapters for cracks and damage. Replace any damaged parts.

Compressor Cooling

Air flowing through the engine compartment from the action of the engine fan and the movement of the coach assists in cooling the compressor. Coolant flowing from the engine cooling system through connecting lines enters the head and passes through internal passages in the cylinder head and is returned to the engine (Figure 9). Proper cooling is important in maintaining discharge air temperatures below the maximum recommended 400°F.

Every 50,000 miles (80,000 km) or 1,500 operating hours inspect the compressor discharge port, inlet cavity and discharge line for evidence of restrictions and carboning. If excessive buildup is noted, thoroughly clean or replace the affected parts and closely inspect the compressor cooling system. Check all compressor coolant lines for kinks and restrictions to flow. Minimum coolant line size is 3/8 inch I.D. Check coolant lines for internal clogging from rust scale. If coolant lines appear suspicious, check the coolant flow and compare to the specifications at the end of this section.

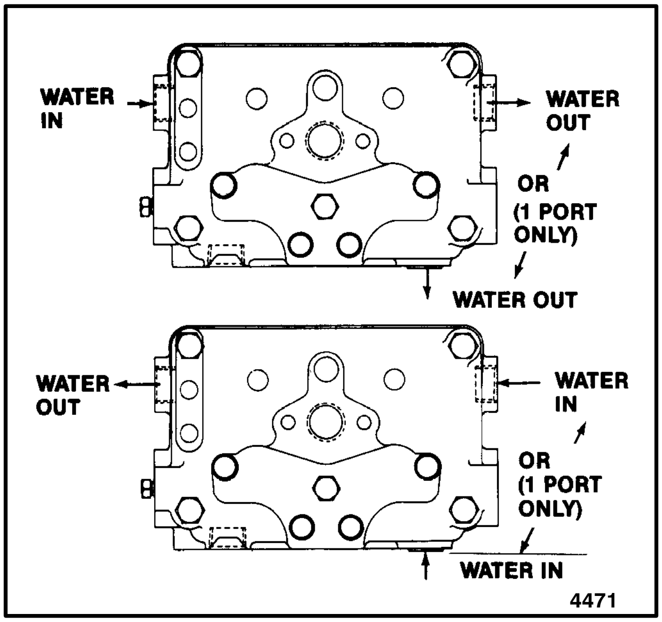


Figure 9. Cooling

Compressor Drive

Every 50,000 miles (80,000 km) or 1,500 operating hours check for noisy compressor operation, which could indicate a worn drive gear coupling, or excessive internal wear. Adjust and/or replace as necessary. Check all compressor mounting bolt torques.

Compressor Leakage Tests

Compressor leakage tests need not be performed on a regular basis. These tests should be performed when discharge valve leakage is substantially affecting compressor performance, or when it is suspected that the compressor is “cycling” between the load and unloaded modes due to unloader piston leakage.

> **NOTE:** The following tests must be performed with the coach parked on level surface, engine off and the entire air system completely drained.

The unloader pistons can be checked for leakage as follows: With the cylinder head removed from the compressor and the inlet flange securely covered, apply 120 psi of air pressure to the governor port. Listen for an escape of air at the inlet valve area. An audible escape of air should not be detected.

> **NOTE:** Any unloader piston leakage must be repaired before this test is performed.

Leakage past the discharge valves can be detected as follows: remove the discharge line and apply shop air back through the discharge port. Listen for an escape of air at the compressor inlet cavity. A barely audible escape of air is generally acceptable.

> **NOTE:** If the compressor does not function as described above or if the leakage is excessive, repair and retest. The compressor must be capable of raising system air pressure from 85 psi to 100 psi in 25 seconds or less. This test is performed with the engine at maximum governed speed with minimum required reservoir capacity (FMVSS 121).

Every 50,000 miles (80,000 km) or 1,500 operating hours perform the “Operational and Leakage” tests.

Governor Operating Test

Start the engine and build up air pressure in the system. Observe reading on air pressure gauge in gauge panel when governor cuts out stopping air compression by the compressor. Reading on gauge when governor cuts out should be 1 psi.

With the engine still running, slowly reduce air pressure in the system by applying and releasing the brakes. Observe pressure registered by gauge when governor cuts in and compression is resumed. Gauge reading when governor cuts in should be 110 psi.

Before condemning or adjusting the governor, be sure the dash air gauge is registering accurately. Use an accurate test gauge to check pressure registered by the dash gauge.

If the pressure settings of the Type "D-2" governor are inaccurate or it is necessary that they be changed, adjust the governor as described below:

Governor Leakage Test

Leakage checks on the governor are made at its exhaust port in both cut-in and cut-out positions. In the cut-in position, check exhaust port for inlet valve leakage by applying a soap solution at the port. Leakage could also be past the bottom piston grommet. In the cut-out position, check the exhaust port to determine if leakage is present at the exhaust valve seat or stem grommet. In this position, leakage could also be past the upper piston grommet.

NOTE: Leakage in excess of a one-inch soap bubble in three seconds is not permissible in either of the above tests.

MAINTENANCE

⚠ WARNING ⚠

When working on the coach compressor, the following general precautions should be observed:

1. Park the coach on a level surface, apply the parking brakes, and always block the wheels.
2. Make certain to drain the air pressure from all reservoirs before beginning any work on the coach.
3. Disconnect the batteries at the switches in the battery compartment.
4. Always wear safety glasses.
5. When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, extreme caution should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.
6. Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.
7. Never exceed recommended pressures.
8. Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.
9. Use only vendor replacement parts, components, or repair kits. Replacement hardware, tubing, hose, fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.
10. Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the coach or component manufacturer.
11. Prior to returning the coach to service, make certain all components and systems are restored to their proper operating condition.

GOVERNOR

Adjustment

1. Unscrew cover at top of the governor.
2. Loosen adjusting screw locknut.
3. Using a screwdriver, turn adjusting screw counterclockwise to raise pressure settings. Turn adjusting screw clockwise to lower the pressure setting.
4. When adjustment is completed, tighten adjusting screw locknut.
5. Install cover on the governor.

NOTE: Unloading and loading set pressures are factory set. Set pressures are plus or minus 5 psi. (120 psi. Unload) and (100 psi. Loaded)

Air Filter Removal

Every 25,000 miles (40,000 km) or 750 operating hours the governor reservoir and unloader port air filters must be removed and cleaned.

1. Follow steps 1 and 2 of the governor "Removal" procedure.
2. Remove the governor filters and clean with solvent.

Removal

1. Turn the battery disconnect to "Off". Block the wheels of the coach and vent the entire air system.
2. Tag and disconnect the two air lines attached to the compressor governor.
3. Unfasten and remove the two mounting capscrews, and remove the governor and its gasket from the compressor.

Disassembly

Key numbers in the following procedures steps are shown on (Figure 10).

1. Using cleaning solvent and a brush, clean dirt and grease from exterior of the governor.
2. Using fingers, remove rubber cover (1) from governor assembly. Remove two pipe plugs from the governor body (19).
3. Using Tru-Arc pliers, remove cover retaining ring (2) from groove in governor body.
4. Remove adjusting screw and spring assembly from governor body.
5. Remove the piston assembly from governor body. It may be necessary to tap the body flat against a work bench to dislodge the piston.
6. Remove two piston grommets (10 and 18) from grooves in piston (15). Discard grommets.
7. Remove valve springs (17), valve (16), exhaust stem (11), and exhaust stem spring (12) from piston.
8. Remove exhaust stem grommet (14) and washer (13) from bore. Discard grommet.
9. Mount adjusting screw and spring assembly in a vise with soft jaws.
10. Carefully measure distance locknut (3) is threaded on adjuster screw (9) before removing it in Step 11 following.
11. Remove locknut from adjuster screw, then thread adjuster screw out of upper spring seat (4).
12. Remove spring (5), lower spring seat (6), spring guide (7), and second lower spring seat (8) from adjuster screw.

Cleaning and Inspection

1. Wash all metal parts in cleaning solvent. Blow parts dry. Wipe rubber parts dry.
2. Check valve spring (17), exhaust spring (12), and adjuster screw spring (5) for free length, compressed length, distortion, or collapsed coils. See “Specifications” at end of this section.
3. Inspect governor body (19) for cracks, nicks, burrs, or other damage. Check for crossed or stripped threads.
4. Inspect adjuster screw (9) for crossed or stripped threads and distortion.
5. Examine the piston (15) for nicks, burrs, or other damage.
6. Check governor valve (16) for deterioration or other damage.
7. Examine the two filters in the governor body. If damaged, use a sharp hooked tool and remove them. Use a suitable sleeve and press new filters into governor body ports.

Assembly

Prior to assembly, lubricate the governor body bore, top of piston grooves, piston grommets, spring guide, and adjusting screw. Use lubrication specification S-26 (Silicon Grease – DOW CORNING 55 O-Ring Lube) as shown in Section 10 of this manual.

1. Position first lower spring seat (8), spring guide (7), second lower spring seat (6), and spring (5) on adjuster screw (9).
2. Thread adjuster screw into upper spring seat (4), then mount adjuster screw and spring assembly in a vise having soft jaws.
3. Install locknut (3) on adjuster screw. Turn nut on screw the same distance measured at disassembly.
4. Position a new exhaust stem grommet (14) in groove inside piston (15). Install new washer (13) in piston. Prick punch washer in four places.
5. Install two new grommets (10 and 18) in groves on outside of piston.
6. Position exhaust stem spring (12), exhaust stem (11), valve (16), and valve spring (17) in piston.
7. Insert piston assembly in bore of governor body.
8. Position adjusting screw and spring assembly in governor body. Then using Tru-Arc pliers, install retaining ring (2).
9. Install new rubber cover (1) on governor body (19).
10. If previously removed, install two pipe plugs in governor body.
11. After the governor is installed in the coach, perform “Governor Tests” described previously.

Installation

1. Reinstall the governor in the reverse order of the disassembly procedure.

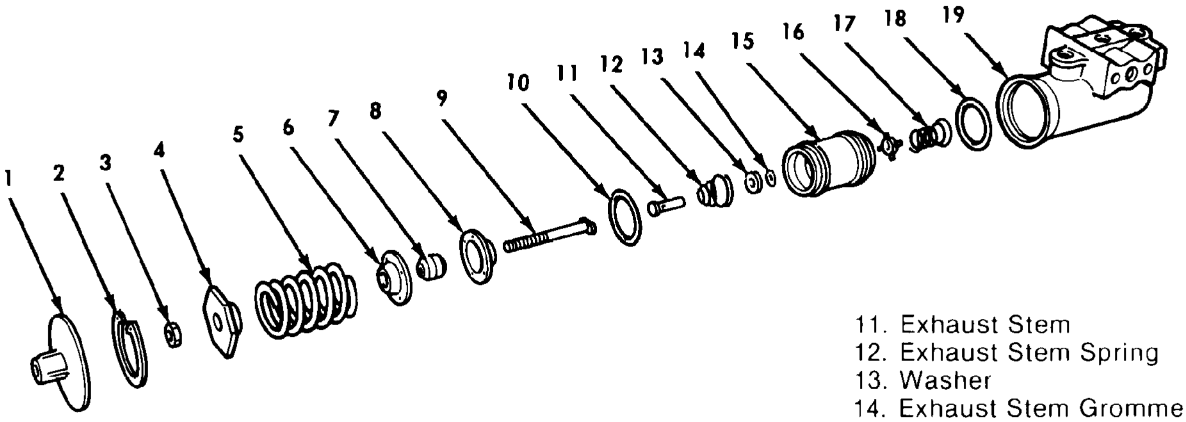
COMPRESSOR

Every 200,000 miles (322,000 km) or 6,000 operating hours remove, disassemble, clean and inspect all the compressor parts thoroughly. Replace all worn or damaged parts or replace the compressor with a remanufactured unit.

Removal

These instructions are general and are intended to be a guide, in some cases additional preparations and precautions are necessary.

1. Turn the battery disconnect to “Off”. Block the wheels of the coach and vent the entire air system.
2. Drain the engine cooling system and the cylinder head of the compressor. Identify and disconnect all air, water and oil lines leading to the compressor.
3. Remove the governor and any support brackets. Use the previous “Governor Removal” procedure.



1. Rubber Cover
2. Cover Retaining Ring
3. Locknut
4. Upper Spring Seat
5. Adjuster Screw Spring
6. Lower Spring Seat
7. Spring Guide
8. Lower Spring Seat
9. Adjuster Screw
10. Piston Grommet
11. Exhaust Stem
12. Exhaust Stem Spring
13. Washer
14. Exhaust Stem Grommet
15. Piston
16. Valve
17. Valve Spring
18. Piston Grommet
19. Governor Body

4456

Figure 10. Type “D-2” Governor Components

4. Match mark mounting flange to engine front gear case for proper orientation at reinstallation.

5. Remove the discharge and inlet fittings and note their positions on the compressor to aid in assembly.

6. Remove the flange mounting bolts and remove the compressor from the coach.

7. Remove the drive gear from the compressor crankshaft using a gear puller. Inspect the gear and associated parts for visible wear or damage. Since these parts are precision fitted, they must be replaced if they are worn or damaged.

> **NOTE:** The following “Disassembly” and “Assembly” procedures is presented for reference purposes and presupposes that a major rebuild of the compressor is being undertaken.

Disassembly

Several maintenance kits are available which do not require full disassembly. The instructions provided with these parts and kits should be followed in lieu of the instructions presented here. Refer to Figure 11 for numbers appearing in the following steps.

1. Remove any road dirt and grease from the exterior of the compressor with a cleaning solvent.

2. Before the compressor is disassembled, the following items should be match marked to show their relationship when the compressor is assembled.

A. Mark the rear end cover in relation to the crankcase.

B. Mark the base plate in relation to the crankcase.

C. Mark the cylinder head in relationship to the crankcase.

> **NOTE:** A convenient method to indicate the above relationships is to use a metal scribe to mark the parts with numbers or lines. Do not use marking methods such as chalk that can be wiped off or obliterated.

Cylinder Head

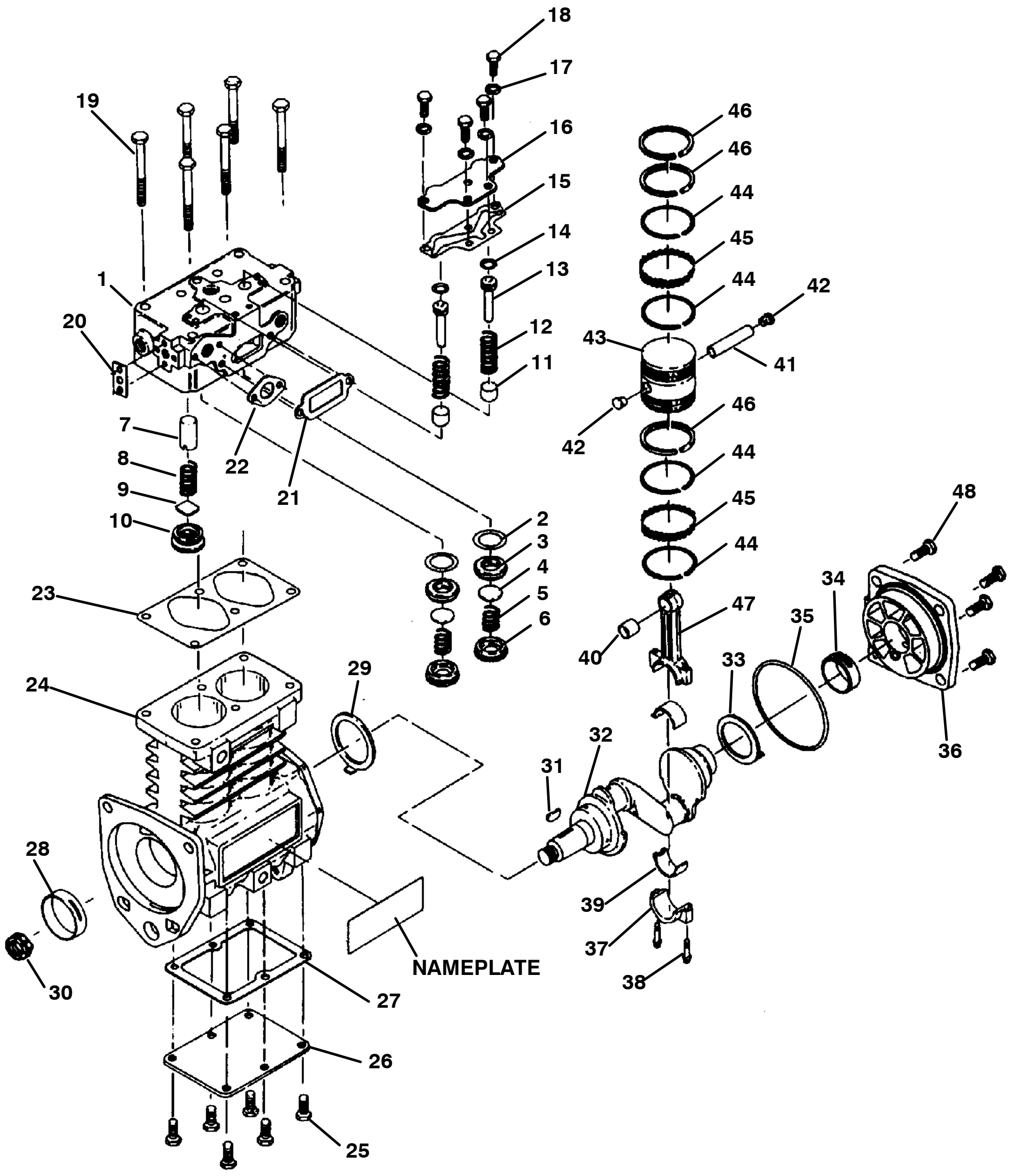
1. Remove the six cylinder head capscrews (19) and tap the head with a soft mallet to break the gasket seal.

2. Remove the unloader cover plate capscrews (18), lockwashers (17) and the unloader cover plate (16).

3. Scrape off any gasket material (15) from the cover plate, cylinder head and crankcase.

4. Remove the unloader pistons (13), O-rings (14) and springs (12).

5. Inspect the unloader piston bushings (11) for nicks, wear, corrosion and scoring. It is recommended that the compressor be replaced if it is determined that the unloader bushing is damaged or worn excessively. Before disassembling the discharge valve mechanism, measure and record the discharge valve travel (from closed to completely open).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NAMEPLATE
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1. CYLINDER HEAD
2. INLET VALVE SEAT GASKET
3. INLET VALVE SEAT
4. INLET VALVE
5. INLET VALVE SPRING
6. INLET VALVE STOP
7. DISCHARGE VALVE STOP
8. DISCHARGE VALVE SPRING
9. DISCHARGE VALVE
10. DISCHARGE VALVE SEAT
11. UNLOADER BUSHING
12. UNLOADER SPRING
13. UNLOADER PISTON
14. UNLOADER O−RING
15. UNLOADER PLATE GASKET
16. UNLOADER PLATE
17. UNLOADER LOCKWASHER (5/16)
18. UNLOADER CAPSCREW (5/16)
19. CYLINDER HEAD CAPSCREW (3/8)
20. GOVERNOR GASKET
21. STRAINER GASKET
22. DISCHARGE FITTING GASKET
23. CYLINDER HEAD GASKET
24. CRANKCASE
25. BASE PLATE CAPSCREW (5/16)
26. BASE PLATE
27. BASE GASKET
28. FRONT BEARING
29. THRUST WASHER
30. CRANKSHAFT NUT
31. CRANKSHAFT KEY
32. CRANKSHAFT
33. THRUST WASHER
34. SLEEVE BEARING
35. END COVER SEAL
36. END COVER
37. CONNECTING ROD CAPS
38. CONNECTING ROD BOLTS
39. CONNECTING ROD INSERTS (SETS)
40. WRIST PIN BUSHING
41. WRIST PIN
42. WRIST PIN BUTTON
43. PISTON
44. OIL RING
45. EXPANDER RING
46. STANDARD PISTON RINGS
47. CONNECTING ROD
48. END COVER CAPSCREW

4410

Figure 11. Tu-Flo® 750 Air Compressor

6. If the measured discharge valve travel exceeds 0.046 inch, the compressor should be replaced. If the discharge valve travel does not exceed 0.046 inch, using a 3/16 inch allen wrench, remove the discharge valve seats (10), valves (9) and valve springs (8).

7. Remove the inlet valve stops (6), valves (9), valve seats (3), valve springs (5) and gaskets (2). It is recommended that a tool such as a J-25447-B be used to remove the inlet valve stop.

Crankcase Bottom Cover

1. Remove the capscrews (25) securing the bottom cover or adapter (26).

2. Tap with a soft mallet to break the gasket seal.

3. Scrape off any gasket material (27) from the crankcase and bottom cover or adapter.

Piston & Connecting Rod

NOTE: Before removing the connecting rod, mark the connecting rods (47) and their caps (37) to ensure correct reassembly. The connecting rod and cap are a matched set therefore the caps must not be switched or rotated end for end.

1. Remove the connecting rod bolts (38) and bearing caps (37).

2. Push the piston (43) with the connecting rod (47) attached out the top of the cylinder bore of the crankcase. Replace the bearing caps on the connecting rods.

3. Remove the piston rings (44-46) from the piston. If the piston is to be removed from the connecting rod, remove the wrist pin teflon plugs (42) and press the wrist pin (41) from the piston and connecting rod.

4. If the piston is removed from the rod, inspect the wrist pin bore in the piston and bronze wrist pin bushing (40) in the connecting rod. If excessive wear is noted or suspected, replace the connecting rod and piston.

Crankshaft

1. Remove the key (31) from the crankshaft (32) and deburr crankshaft.

2. Remove the four capscrews (48) and lockwashers or nuts and lockwashers that secure the rear end cover (36) to the crankcase.

3. Remove the rear end cover (36), thrust washer (33) and end cover oil seal ring (35), taking care not to damage any bearing if present in the end cover, and remove the crankshaft from the end cover.

Check for cracks and external damage. Check the crankshaft main bearing (34) for excessive wear and flat spots and replace if necessary. Check all crankcase surfaces for cracks and damage. Check the precision sleeve main bearings, the difference between the O.D. of the crankshaft journal and the main bearing I.D. must not exceed 0.005 inch. If the clearance is greater than 0.005 inch, the bearing must be replaced.

The cylinder bores should be checked with inside micrometers or calipers. Cylinder bores which are scored or out of round by more than 0.0005 inch or tapered more than 0.0005 inch should be rebored or honed oversize. Oversized pistons and piston rings are available in 0.01, 0.02 and 0.03 inch oversizes. Cylinder bores must be smooth, straight and round. Clearance between the cast iron pistons and cylinder bores should be between 0.002 inch minimum and 0.004 inch maximum.

Check the pistons for scores, cracks or enlarged ring grooves; replace the pistons if any of these conditions are found. Measure each piston with a micrometer in relation to the cylinder bore diameter to be sure the diametrical clearance is between 0.002 inch minimum and 0.004 inch maximum.

Cleaning

All parts should be cleaned in a good commercial grade solvent and dried prior to inspection. Thoroughly clean all oil passages through the crankshaft, crankcase, end covers, base plate or base adapter. Inspect the passages with a wire to be sure. Blow the loosened foreign matter out with air pressure.

Remove any carbon deposits from the discharge cavity and rust and scale from the cooling cavities of the cylinder head body. Scrape all foreign matter from the body surfaces. Clean carbon and dirt from the inlet and unloader passages. Use shop air to blow the carbon and dirt deposits from the discharge and unloader passages.

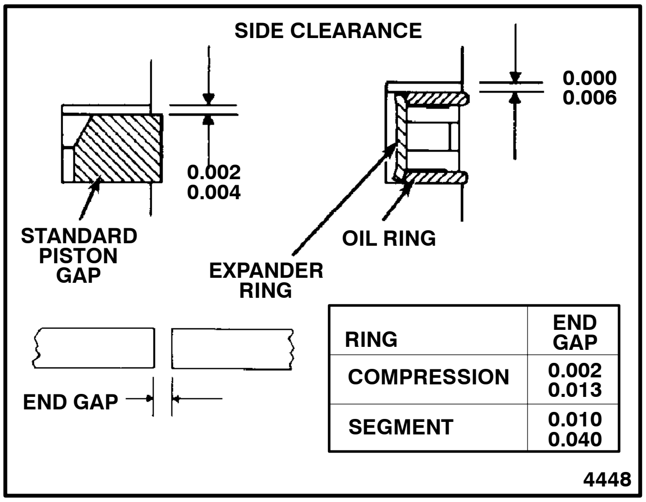
Inspection

Inspect the cylinder head for any cracks or damage and secure it with gasket to a flat surface for pressure testing. Plug all coolant ports except one. Apply shop air and check for leakage by applying a soap solution.

Check the fit of the wrist pins to the pistons and connecting rod bushings. The wrist pin should be a light press fit in the piston. If the wrist pin is a loose fit, the piston and pin assembly should be replaced.

Check the fit of the wrist pin in the connecting rod bushing by rocking the piston. This clearance should not exceed 0.0007 inch, include the wrist pin bushings if excessive clearance is found.

Check the fit of the rings in the piston ring grooves. Check the ring gap with the rings installed in the cylinder bores. Refer to Figure 12 for correct gap and groove clearances.



RING	END GAP
COMPRESSION	0.002 0.013
SEGMENT	0.010 0.040

Figure 12. Ring Configuration

Check the crankshaft threads, keyways, tapered ends and all machined and ground surfaces for wear, scores, or damage. Standard crankshaft journals are 1.1242-1.1250 inches in diameter. If the crankshaft journals are excessively scored, worn or out of round and cannot be reground, the compressor must be replaced. Connecting rod bearing inserts are available in .010, .020, and .030 inch undersizes for compressors with reground crankshafts. Main bearing journals must be maintained so the ball bearings are a snug fit or so that no more than 0.005 inch clearance exists between the precision sleeve main bearing and the main bearing journals on the crankshaft. Check to be sure the oil passages are open through the crankshaft.

Used bearing inserts must be replaced. The connecting rod and cap are a matched set and therefore the caps must not be switched or rotated end for end. The solid inserts must be installed in the rod and the slotted inserts into the cap. Make sure the locating tangs on the inserts engage with the locating notches in the rod and cap. Clearance between the connecting rod journal and the connecting rod bearing must not be less than 0.003 inch or more than 0.0021 inch after rebuilding.

Assembly

NOTE: All torques specified in this section are assembly torques and typically can be expected to fall off after assembly is accomplished. Do not retorque after initial assembly torques fall unless instructed otherwise. A listing of torque specifications is included at the end of this section.

4. A new cylinder head maintenance kit should be used when rebuilding. The unloader pistons in the kit are prelubricated with a special lubricant. Install the springs and unloader pistons in their bores being careful not to cut the O-rings.

5. Install the unloader cover gasket and unloader cover and secure the cover capscrews. Tighten the capscrews to 175-225 in-lbs in a crossing pattern after first snugging all screws.

6. If the discharge valve seats merely show signs of slight wear, they can be dressed by using a lapping stone, grinding compound and grinding tool; however, it is recommended that a cylinder head maintenance kit be used. Install new discharge valve springs and valves. Screw in the discharge valve seats and tighten to 70-90 ft-lbs. Discharge valve travel should be between 0.030-0.046 inch.

NOTE: To test for discharge valve leakage, apply 100 psi to the cylinder head discharge port and apply a soap solution to the discharge valve and seats. If excessive leakage is found, leave the air pressure applied and using a fiber or hardwood dowel and a hammer, tap the discharge valves off their seats several times. This will help the valves to seat and should reduce the leakage.

With air pressure still applied at the discharge port of the cylinder head, check for leakage around the discharge valve stop on the top of the cylinder head casting. No leakage is permitted.

7. Inlet valves and springs should be replaced. However, if the inlet valve seats show signs of slight nicks or scratches, they can be redressed with a fine piece of emery cloth or by lapping with a lapping stone, grinding compound and grinding tool. If the seats are damaged to the extent that they cannot be reclaimed, they must be replaced.

8. Press new sleeve bearings in the end cover and crankcase. Ensure that the slot in the bearings lines up with the oil passages in the end cover and crankcase.

9. Install the front thrust washer with the tang inserted in the slot toward the flange.

10. Insert the crankshaft and the rear thrust washer with the tang toward the rear of the compressor. Place the oil seal ring on the boss of the rear end cover and install the end cover making sure not to pinch the seal ring.

11. Ensure the tang of the thrust washer is inserted in the slot of the end cover. Fasten the end cover to the crankcase with the four cover capscrews. Torque the capscrews to 175-225 in-lbs in a cross pattern.

12. Position the base plate gasket (27) on the crankcase, and install the base plate (26) as marked before disassembly.

13. Tighten the six capscrews (25) securing the cast iron base adapter evenly to a torque of 175-225 in-lbs for

base plate in a crossing pattern after first snugging all 6 screws.

Place the cylinder head gasket (23) and cylinder head on the compressor crankcase and install the six cylinder head capscrews.

NOTE: If the cylinder head gasket has a bead on one side, install the gasket on the crankcase with the beaded side up.

14. Snug the cylinder head capscrews to 440-500 in-lbs in a cross pattern. Retorque the unloader cover capscrews to 170-225 in-lbs.

15. Install all crankshaft keys making certain to support the crankshaft to avoid bearing damage.

16. Install the crankshaft nut where applicable. When installing drive couplings or gears, DO NOT EXCEED 120 ft-lbs torque on the crankshaft nut.

NOTE: Use covers, plugs, or masking tape to protect all ports if compressor is not to be installed immediately. Protect the ends of the crankshaft against damage by wrapping with masking tape or friction tape.

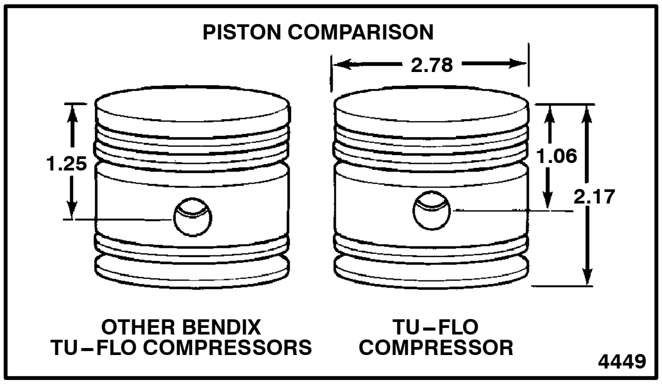


Figure 13. Piston Comparison

NOTE: If the pistons are being replaced, ensure that the correct pistons are being installed. The pistons for the Tu-Flo® 750 compressor are similar to those of other Bendix compressor models, but may be identified by the piston diameter and the distance to the center of the wrist pin from the top of the piston. (Figure 13).

Ring Installation

Check each ring end gap in a cylinder bore before installation. Place the ring in the top of the cylinder bore and using the piston, push the ring to the mid-point of the cylinder bore and check the ring gap. If the end caps are incorrect, either the wrong repair size has been purchased or the compressor is worn beyond specification and should be replaced.

Install the rings on the pistons per the following instructions starting at the center of the piston and moving outward, referring to Figure 11.

1. Install the spacer and segment rings as follows. Place the spacer ring (45) in the piston groove, the ends of the spacer must butt and not overlap.

2. Install the top segment (44) by inserting one end above the spacer in the ring groove, 120 degrees from the spacer ends and wind the segment into position.

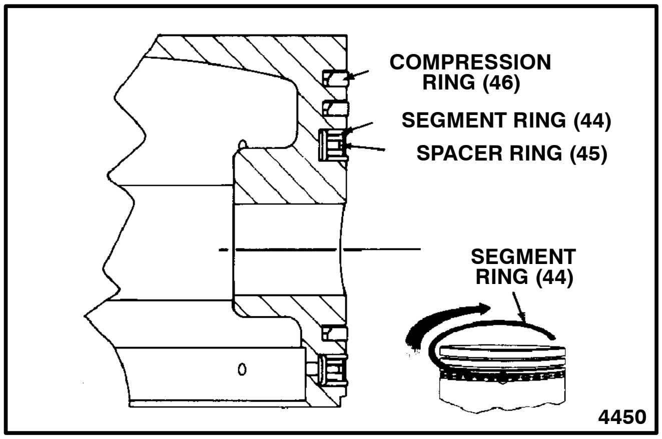


Figure 14. Piston and Rings

3. Install the bottom segment in the same manner beneath the spacer making sure the gap is staggered 120 degrees from both the top ring segment and the spacer end gaps. Before using be sure both painted ends of the spacer are visible and butted (Figure 14).

4. Install the compression rings (46) in the proper grooves with the bevel or “pip” mark (if any) toward the top of the piston (Figure 12).

5. Check the ring side clearance of each ring in the piston ring groove (Figure 12). If the side clearance is too large, the piston ring groove is worn beyond specifications and the piston must be replaced.

6. Rotate the piston rings in their respective groove so that each end gap is at least 90 degrees from the previous ring’s end gap.

Piston And Rod Sub-Assembly

1. Lubricate the wrist pin (41) and wrist pin bushing in the connecting rod with engine oil.

2. Assemble the upper portion of the connecting rods and the pistons with the wrist pins.

3. Insert the wrist pin buttons (42) in the ends of the wrist pin.

4. Lubricate the pistons and rings with engine oil and insert the piston in the cylinder bore.

5. Turn the crankshaft so that one of its connecting rod journals is in the downward, center position.

6. Install the crankshaft journal bearing segments (39) on the connecting rod (47) and connecting rod cap (39).

7. Tighten the connecting rod bolts (38) evenly and torque to 150-170 in-lbs.

8. Install the other connecting rod and piston in the same manner. It is recommended that new connecting rod capscrews be used.

> **NOTE:** Before replacing the cylinder head on the crankcase, ensure the correct pistons have been used by turning crankshaft one complete revolution such that each piston moves to its maximum upward stroke. At the maximum upward stroke position, each piston should move to the top of the crankcase. If the piston does not approach the top of the crankcase the piston is incorrect and if not replaced could result in compressor damage.

Operational Test

To properly test a compressor under operating conditions, a test stand for mounting, cooling, lubricating, and driving the compressor is necessary. Such tests are not compulsory if the unit has been carefully rebuilt by an experienced person. An engine lubricated compressor must be connected to an oil supply line of at least 15 psi pressure during the test and an oil return line must be installed to keep the crankcase drained. Connect the compressor discharge port to a reservoir with a capacity of 1,500 cubic inches. A properly rebuilt compressor should raise the reservoir pressure from 85 psi to 100 psi in approximately five (5) seconds. During testing the compressor should be checked for gasket leakage and noisy operation, as well as unloader operation and leakage. If the compressor functions as indicated, reinstall on the coach and connect all lines removed during the disassembly procedure.

Installation

1. Reinstall the compressor in the reverse order of the disassembly procedure.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
1. Compressor passes excessive oil as evidenced by presence of oil at exhaust ports of valving or seeping from air strainer.	A. Restricted air intake.	A. Check engine or compressor air cleaner and replace if necessary. Check compressor air inlet for kinks, excessive bends and be certain inlet lines have the minimum specified inside diameter. Recommended minimum inlet line inside diameter is 5/8 inch. Recommended maximum air inlet restriction is 25 inches of water.
	B. Restricted oil return (to engine).	B. Oil return to the engine should not be in any way restricted. Check for excessive bends, kinks and restrictions in the oil return line. Minimum recommended oil return line size is 5/8 inch O.D. tubing or equivalent I.D. (1/2 inch minimum). Return line must CONSISTENTLY DESCEND from the compressor to the engine crankcase. Make certain oil drain passages in the compressor and mating engine surfaces are not obstructed and aligned. Special care must be taken when sealants are used with or instead of gaskets.
	C. Poorly filtered inlet air.	C. Check for damaged, defective or dirty air filter on engine or compressor. Check for leaking, damaged or defective compressor air intake components (i.e., induction line, fittings, gaskets, filter bodies, etc.). The compressor intake should not be connected to any part of the exhaust gas recirculation (E.G.R.) system on the engine.
	D. Insufficient compressor cooling (compressor runs hot).	D. Remove accumulated grease, grime or dirt from the cooling fins. Replace components found damaged. Check for damaged cooling fins. Replace components found damaged.
	E. Contaminants not being regularly drained from system reservoirs.	E. Check reservoir drain valves to ensure that they are functioning properly.
	F. Compressor runs loaded an excessive amount of time.	F. Coach system leakage should not exceed 1 psi pressure drop per minute without brakes applied and 3 psi pressure drop per minute with brakes applied. If leakage is excessive, check for system leaks and repair.

TROUBLESHOOTING (Contd.)

	G. Excessive engine crankcase pressure.	G. Test for excessive engine crankcase pressure & replace or repair ventilation components as necessary. (An indication of crankcase pressure is a loose or partially lifted dipstick.)
	H. Excessive engine oil pressure.	H. Check the engine oil pressure with a test gauge and compare the reading to the engine specifications. Bendix does not recommend restricting the compressor oil supply line because of the possibility of plugging the restriction with oil contaminants. Minimum oil supply line size is 3/8 inch I.D. tubing.
	I. Faulty compressor.	I. Replace or repair the compressor only after making certain none of the preceding installation defects exist.
2. Noisy compressor operations.	A. Loose drive gear.	A. Inspect the drive gear fit on the compressor crankshaft. The gear must be completely seated and the crankshaft nut must be tight. If the crankshaft surface or its keyway are damaged, it is an indication of loose drive components. If damage to the compressor crankshaft is detected, replace the compressor. When installing the drive gear, torque the crankshaft nut to the appropriate torque specifications. DO NOT BACK OFF THE CRANKSHAFT NUT TO ALIGN THE COTTER PIN AND CASTELLATED NUT. (Some compressors do not use castellated nuts.) DO NOT USE IMPACT WRENCHES.
	B. Excessively worn drive couplings or gears.	B. Inspect drive gear and couplings and engine for excessive wear. Replace as necessary. (Nonmetallic gears should be replaced when the compressor is changed.)
	C. Compressor cylinder head or discharge line restrictions.	C. Inspect the compressor discharge port and discharge line for carbon buildup. If carbon is detected, check for proper cooling to the compressor. (See Cause and Remedy (D) under Symptom #1.) Inspect the discharge line for kinks and restrictions. Replace discharge line as necessary.
	D. Poorly filtered inlet air.	D. Check for proper oil pressure in the compressor. Minimum required oil pressure; 15 psi engine idling, 15 psi maximum governed engine rpm. Check for excessive oil temperature - should not exceed 240°F.

TROUBLESHOOTING (Contd.)

	E. Faulty compressor.	E. Replace or repair the compressor after determining none of the preceding installation defects exist.
3. Excessive buildup and recover time. Compressor should be capable of building air system from 85-100 psi in 40 seconds with engine at full governed rpm. Minimum compressor performance is certified to meet Federal requirements by the coach manufacturer. Do not down size the original equipment compressor.	A. Dirty induction air filter.	A. Inspect engine or compressor air filter and replace if necessary.
	B. Restricted induction line.	B. Inspect the compressor air induction line for kinks and restrictions and replace as necessary.
	C. Restricted discharge line or compressor discharge cavity.	C. Inspect the compressor discharge port and line for restriction and carbon buildup. If a carbon buildup is found, check for proper compressor cooling. Replace faulty sections of the discharge line.
	D. Slipping drive components.	D. Check for faulty drive gears and couplings and replace as necessary.
	E. Excessive air system leakage.	E. Test for excessive system leakage and repair as necessary. Use the following as a guide: Build system pressure to governor cutout and allow the pressure to stabilize for one minute. Using the dash gauge, note the system pressure and the pressure drop after two minutes. The pressure drop should not exceed 2 psi in each reservoir.
	F. Sticking unloader pistons.	F. Check operation of the unloading mechanism. Check proper operation of the compressor air governor. If the governor is operating properly, replace the unloader mechanism. Inspect for bent, kinked or blocked tubing leading to or from the governor.
	G. Faulty compressor.	G. Replace or repair the compressor after determining none of the preceding installation defects exists.

TROUBLESHOOTING (Contd.)

4. Compressor fails to unload.	A. Faulty governor or governor installation.	A. Test the governor for proper operation and inspect air lines to and from the governor for kinks or restrictions. Replace or repair the governor or its connecting air lines.
	B. Faulty or worn unloader pistons or bores.	B. Inspect for worn, dirty or corroded unloader pistons and their bores. Replace as necessary.
5. Compressor leaks oil.	A. Damaged mounting gasket.	A. Check the compressor mounting bolt torque. If the mounting bolt torque is low, replace the compressor mounting gasket before retorquing the mounting bolts.
	B. Cracked crankcase or end cover.	B. Visually inspect the compressor exterior for cracked or broken components. Cracked or broken crankcases or mounting flanges can be caused by loose mounting bolts. The end cover can be cracked by overtorquing fitting or plugs installed in the end cover. Replace or repair the compressor as necessary.
	C. Loose end cover cap cover.	C. Check the capscrew torques and tighten as necessary.
	D. Loose oil supply or return line fittings.	D. Check the torque of external oil line fittings and tighten as necessary.
	E. Porous compressor casing.	E. Replace the compressor if porosity is found.
	F. Mounting flange or end cover, O-ring or gasket - missing, cut or damaged.	F. Replace as necessary.
6. Compressor constantly cycles (compressor remains unloaded for a very short time).	A. Leaking compressor unloader pistons.	A. Remove the compressor inlet air strainer or fitting. With the compressor unloaded (not compressing air), check for air leakage. Replace as necessary.
	B. Faulty governor.	B. Test the governor for proper operation and repair or replace as necessary.
	C. Excessive system leakage.	C. Test for excessive system leakage as instructed in Symptom #3 Remedy E. Reduce leakage wherever possible.
	D. Excessive reservoir contaminants.	D. Drain reservoirs.
7. Compressor head gasket failure.	A. Restricted discharge line.	A. Clear restriction or replace line.

TROUBLESHOOTING (Contd.)

	B. Loose head bolts.	B. Tighten evenly to a torque of 25-30 ft-lbs.
	C. Faulty compressor or head gasket.	C. Check for rough or poorly machined head or block surfaces. Replace compressor as necessary.

MISCELLANEOUS TORQUE SPECIFICATIONS

ASSEMBLY TORQUES

Cylinder Head	440 - 500 in-lbs
Unloader Cover Plate	175 - 225 in-lbs
Discharge Valve Seat	840 - 1080 in-lbs (70-90 ft-lbs)
Inlet Valve Stop	840 - 1080 in-lbs (70-90 ft-lbs)
End Cover	175 - 225 in-lbs
Connecting Rod	150 - 170 in-lbs
Bottom Cover	175 - 225 in-lbs
Air Strainer	125 - 150 in-lbs
Inlet Fitting	125 - 225 in-lbs
Discharge Fitting	125 - 225 in-lbs
Governor	175 - 225 in-lbs
Pipe Plugs	
1/16	35 - 50 in-lbs
1/8	85 - 105 in-lbs
1/4	130 - 170 in-lbs
3/8	160 - 200 in-lbs
1/2	200 - 270 in-lbs
Pipe Bushing	
1/2	175 - 225 in-lbs
Crankshaft Nut	
Marsden or Castle	1200 - 1440 in-lbs (100-120 ft-lbs)
Metric Thread	2640 - 3048 in-lbs (220-254 ft-lbs)

SPECIFICATIONS

AIR COMPRESSOR

Part Number (8V-92 Installation)	4K-7-3
Part Number (Series 60 Installation)	4L-7-75
Part Number (Caterpillar Installation)	4L-7-77
Part Number (Cummins Installation)	4L-7-79
Make	Bendix Westinghouse
Model	Type TU-FLO 750
Average Weight	53
Number of cylinders	2
Bore size	2.78 in.
Stroke	1.87 in.
Displacement @ 1250 RPM	16.5 CFM
Maximum Recommended RPM	2400 RPM
Coolant Flow @	
Minimum RPM	2.5 GPM
Maximum RPM	5 GPM
Approximate Horsepower Required @ 1250 RPM at 120 psig.	3.2
Maximum Inlet Air Temperature	250˚F
Maximum Discharge Air Temperature	400˚F
Minimum Oil Pressure Required	15 psi
Piston	
(standard)	2.77825 in.
(0.010 oversize)	2.78825 in.
(0.020 oversize)	2.79825 in.
(0.030 oversize)	2.80825 in.
Cylinder Bore	
(standard)	2.7810 in.
(0.010 oversize)	2.7910 in.
(0.020 oversize)	2.8010 in.
(0.030 oversize)	2.8110 in.
Valve Spring	
Free Length	53/64 in.
Solid Length	5/32 in.
Number of Active Coils	3-1/2
Exhaust Stem Spring	
Free Length	19/32 in.
Solid Length	3/64 in.
Number of Active Coils	3
Adjuster Screw Spring	3
Free Length	1-23/32 in.
Solid Length	1-1/64 in.
Number of Active Coils	4-1/2

GOVERNOR

Part Number (8V-92, Series 60 & Cummins Installations)	4L-8-1
Part Number (8V-92, Series 60 & Cummins Installations)	4L-8-4
Make	Bendix Westinghouse
Model	Type D-2
Cut-Out (Unload) Pressure	120 psi.
Cut-In (Load-Up) Pressure	100 psi.

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 5

CLUTCH

SECTION 5

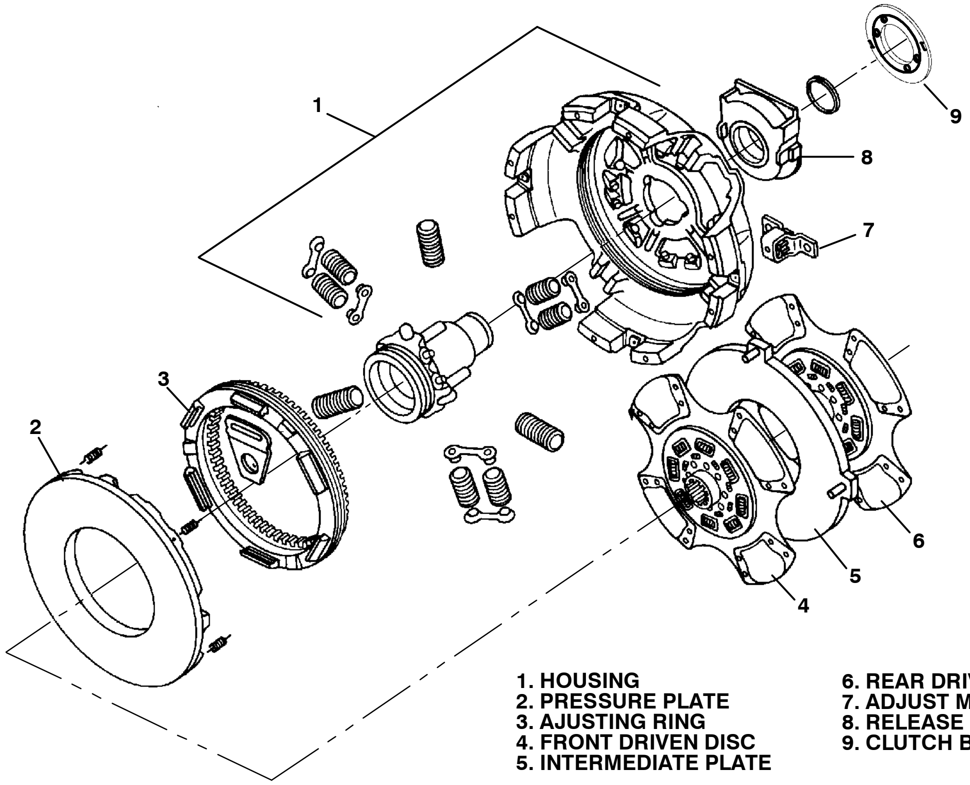
CLUTCH ASSEMBLY

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	5-1
Components	5-2
Operation	5-4
Maintenance	5-4
Troubleshooting	5-14
Specifications	5-16
Service Tools	5-17

GENERAL DESCRIPTION

Coaches with manual transmissions will be equipped with a foot-actuated mechanically operated drive train clutch. The complete installation will feature a fully adjustable clutch assembly and linkage. The clutch assembly is mounted to the engine flywheel, and transfers power, when engaged, to the transmission's input shaft.


1
2
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1. HOUSING
2. PRESSURE PLATE
3. AJUSTING RING
4. FRONT DRIVEN DISC
5. INTERMEDIATE PLATE
6. REAR DRIVEN DISC
7. ADJUST MECNANISM
8. RELEASE BEARING
9. CLUTCH BRAKE
9059

Figure 1. Clutch for 5-Speed Manual Transmission

COMPONENTS

CLUTCH

The clutch assembly used with the 5-speed manual transmission is a 15-1/2 inch dry disc 2-plate model with riveted organic facings on driven discs (Figure 1). The clutch is actuated by a pull-type release bearing fork design. The clutch assembly features a torque-limiting clutch brake. (Information on the clutch brake can be found later in this section.)

Clutch adjustment can be made by turning the adjusting mechanism which is accessible through the inspection plate located on the transmission bell housing. Refer to adjustment procedures later in this section for details.

CLUTCH BRAKE

The torque-limiting clutch brake (Figure 2) helps lengthen the life of the transmission by aiding in smooth gear engagement at those times when the transmission gears may still be in motion even though the coach is stopped. Examples of this situation are (1) stopping at a traffic signal and immediately starting up again or (2) when shifting from first to reverse or from reverse to first gear.

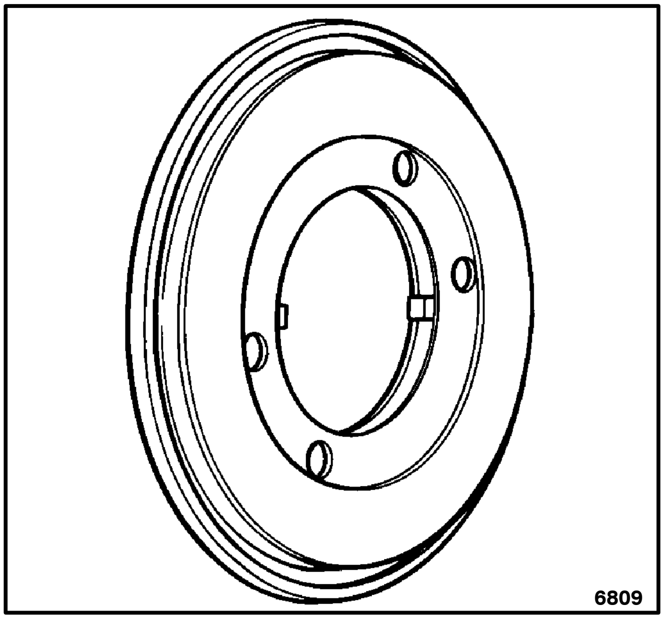


Figure 2. Clutch Brake

The torque-limiting feature is provided by internal spring washers which are driven by a hub. The spring washers react against the clutch brake covers with facing material positioned between each spring washer and cover. The hub and spring washer combination slips with respect to the covers after approximately a 25 ft-lbs load has been exceeded.

Longer tang life is provided by the brake's ability to limit torsionally induced damage. Also, 5 degrees of free play is provided between the hub and spring washers so that the inertia of the spring washers cannot load the hub directly. Inertia present in the covers is allowed to load the hub only up to the 25-30 ft-lbs load mentioned above. And, the tangs themselves are thicker to absorb what remaining torsionals do find their way to the hub.

There is no extra work on the drivers part to activate the brake. Depressing the clutch pedal to the floorboard, beyond the normal clutch disengage position, causes the clutch release bearing to come in contact with the clutch brake. Because the brake is splined to the transmission main drive gear (Figure 3) the transmission's input shaft is slowed and/or stopped. The driver can then shift from first to reverse or from reverse to first without clashing or putting undue strain on the gears.

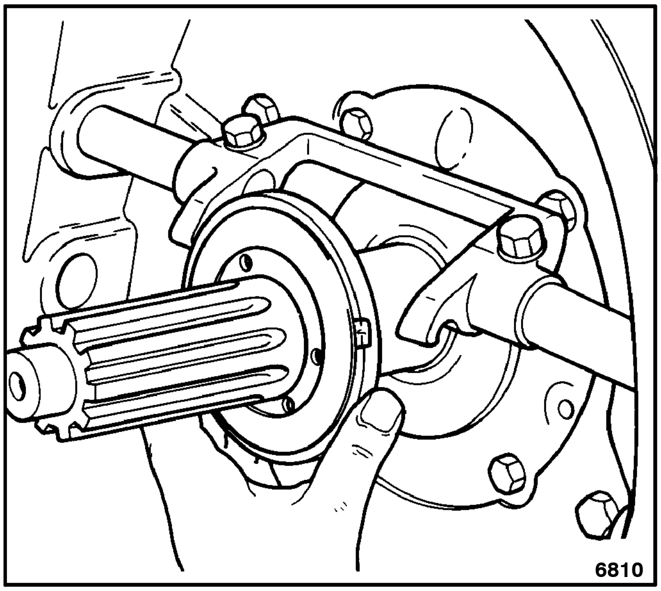


Figure 3. Clutch Brake Installed

CLUTCH LINKAGE

The clutch is actuated by a mechanical linkage (Figure 4) which runs the length of the center control piping tunnel. The linkage includes the pedal assembly, control cable assemblies, cross shaft assembly, control rod assemblies and the actuating lever arm mounted to the release arm of the clutch. The linkage is accessible through the center tunnel covers in baggage bays, under driver's dash area, inside the tire compartment and in the engine compartment.

NOTE: Effective with unit 47722 a cross shaft assembly was added to the clutch linkage.

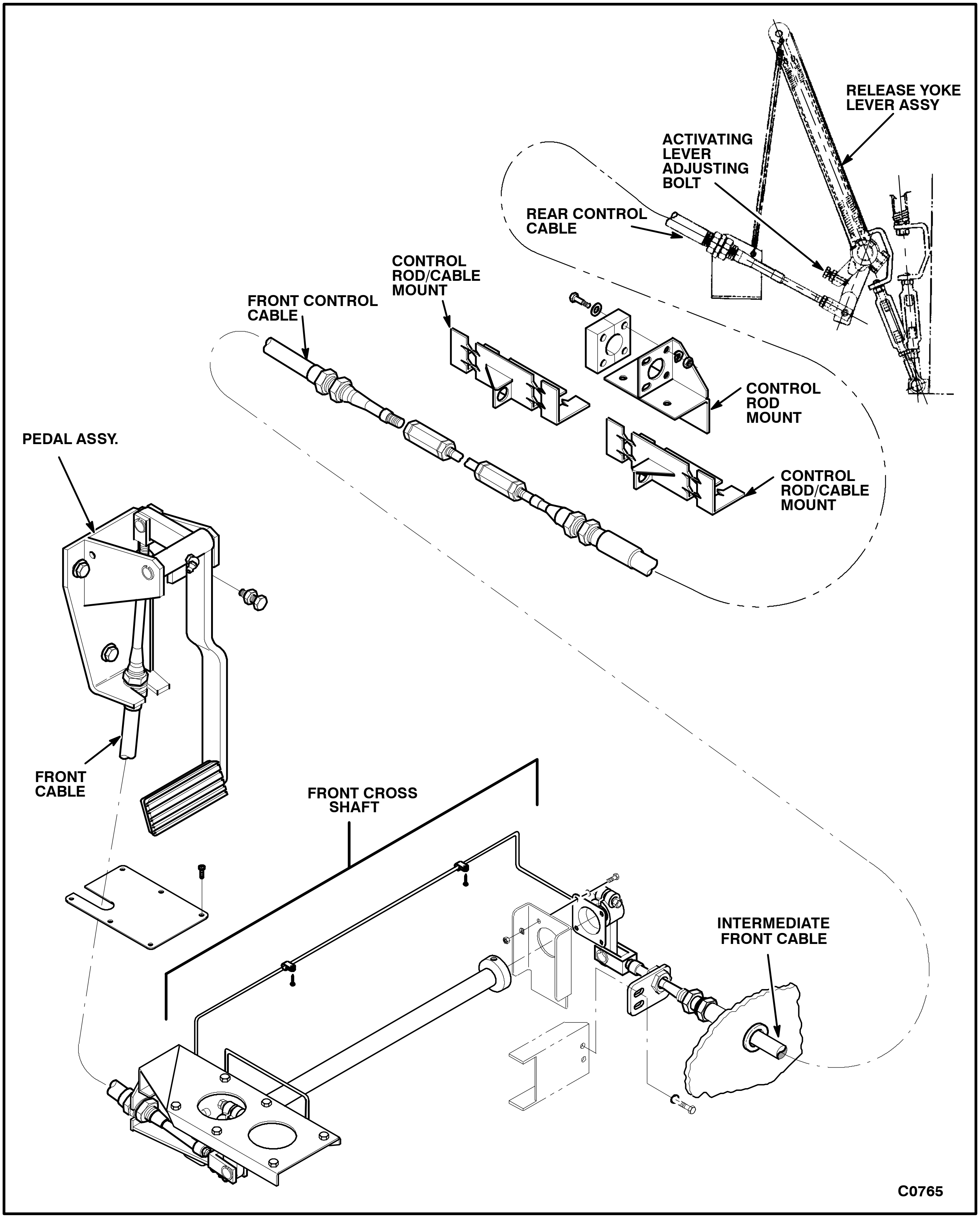

RELEASE YOKE LEVER ASSY
ACTIVATING LEVER ADJUSTING BOLT
REAR CONTROL CABLE
CONTROL ROD/CABLE MOUNT
FRONT CONTROL CABLE
CONTROL ROD MOUNT
CONTROL ROD/CABLE MOUNT
PEDAL ASSY.
FRONT CABLE
FRONT CROSS SHAFT
INTERMEDIATE FRONT CABLE
C0765

Figure 4. Clutch Linkage

OPERATION

Long clutch life requires that the clutch be properly installed, used and maintained. Excess friction heat is responsible for nearly all premature failures of the clutch. Proper operation and maintenance as outlined below will largely eliminate this source of clutch failure.

1. Do not “ride” or “slip” the clutch. Once a clutch is fully engaged, there is no heat generated and little or no wear. However, during the brief period when the clutch is picking up the load, considerable heat is generated. Riding or slipping the clutch causes the period of partial engagement to be lengthened and causes unnecessary heat and wear.
2. Always start in the proper gear. Starting in a gear too high for the coach’s load causes clutch slippage and consequent heat build-up and wear. A gear that will start the coach moving with the engine at idle speed is usually correct. If the engine must be speeded up to prevent stalling, the gear selection is too high.
3. Do not shift until the coach has reached the proper speed. Upshifting before the coach has reached the right speed has nearly the same result as starting off in too high a gear. When the difference between the coach speed and the engine is too great, the clutch is forced to slip which produces extra heat and wear.
4. The clutch provided by MCI is of the proper specification for the coach. Replacing the factory-installed clutch with one of different specifications may result in a clutch that is too light duty, resulting in early burnout. Mismatching the clutch to the coach can also cause early wear on the whole drive train.
5. Never hold the coach on a hill with the clutch. To hold on a hill with the clutch requires that the clutch be purposely slipped. Doing this can generate enough heat to burn up the clutch.
6. Never coast with the clutch disengaged. This can cause clutch failure due to the very high rpm produced by coasting in gear with the clutch released. In this situation, the rear wheels are driving the clutch disc through the multiplication of the rear axle and transmission ratios. This can result in over 10,000 RPM which is beyond the burst strength of the facing material on the disc. Even coasting down a long ramp can burst a driven disc.
7. Never engage the clutch while coasting. Coasting with the clutch disengaged is a dangerous driving practice. Re-engaging the clutch after coasting causes tremendous shock to the clutch and drive train. It can cause internal engine damage and/or clutch and flywheel failure.
8. Always report unusual clutch operation promptly. Proper maintenance, performed on time, will greatly extend the life of the clutch. The driver should report any change in free pedal (free travel), slippage or any strange “feel” to the clutch operation.

MAINTENANCE

LUBRICATION

Clutches should be lubricated after adjustment and at regular maintenance intervals. Lubricate the release bearing through the grease fitting provided on the clutch housing (Figure 5). The clutch cross shaft bearings and yoke shaft end pilots of the transmission bell housing should also be lubricated at these intervals.

Recommend Lubricant

Lubricant for the clutch should be a good quality lithium soap base or equivalent E.P. grease having an operating temperature range of +10°F to +325°F. Additionally, the lubricant should meet the NLGI grades 1 or 2 specifications.

Intervals for lubrication of the clutch depend on service conditions. For regular on-highway service, lubricate the clutch release bearing every 10,000 miles (16,000 km) or monthly. If the coach is operated on unpaved roads more than 10% of the time, the lubrication should be done every 250 hours or monthly.

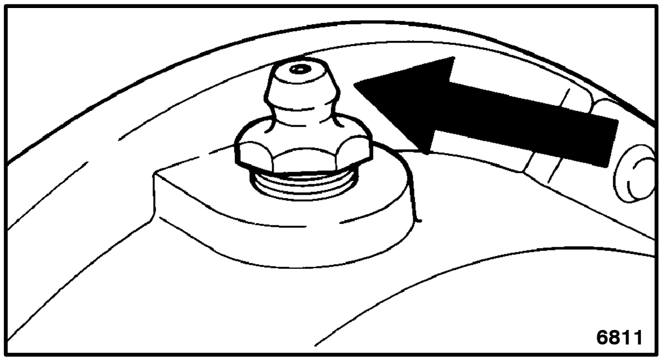


Figure 5. Release Bearing Lubrication Fitting

NOTE: It is important that a high-temperature lubricant be used as listed below. Do not use chassis lubricant.

INSPECTION

Check for binding of the clutch rod and cables between the pedal and clutch, and free is needed. Either the clutch or the linkage (possible both) may require adjustment. The following items should be inspected in order to determine correct clutch assembly setup.

Bearing Release Travel

There should be 1/2-9/16 inch of clutch release travel (Figure 6).

NOTE: Proper release travel assures that the release bearing is capable of releasing far enough, allowing the two driven discs to spin freely, and avoiding clutch drag. never set the clutch release bearing travel with the clutch actuating linkage.

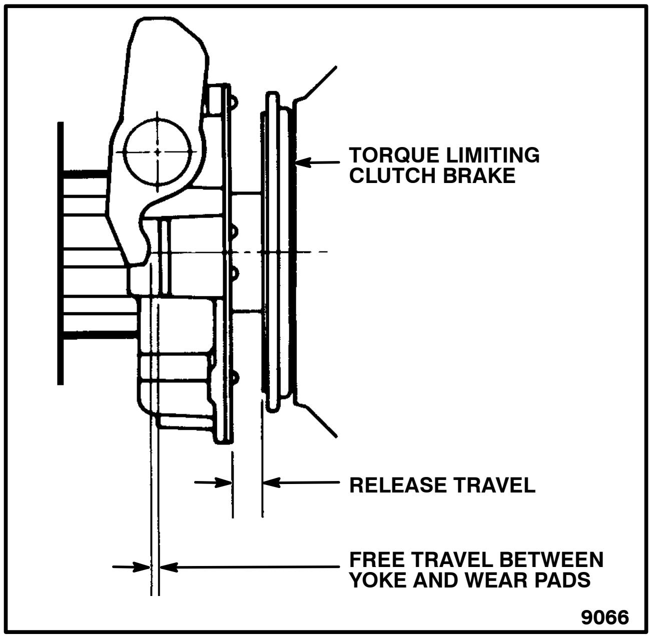

TORQUE LIMITING CLUTCH BRAKE
RELEASE TRAVEL
FREE TRAVEL BETWEEN YOKE AND WEAR PADS
9066

Figure 6. Clutch Release Travel

Bearing Free Travel

There must be approximately 1/8 inch of travel before yoke engages release bearing.

NOTE: Free travel is the clearance between the release yoke and clutch release bearing wear pads. This dimension regulates how much free pedal is obtained.

Clutch Brake (Optional Usage)

Proper clutch brake squeeze should occur approximately 1/2 – 1 inch from the end of the pedal stroke. With a clutch brake, there should be an increase in resistance near the end of the pedal stroke. This adjustment is made by adjusting the external linkage (release bearing yoke actuating lever arm adjustment bolt).

NOTE: Proper clutch brake adjustment may in some instances conflict with the pedal free travel adjustment. In such cases the clutch brake adjustment should be maintained.

NOTE: Proper brake squeeze assures that the input shaft will stop rotating when the vehicle is stationary. This is to help permit shifting into first or reverse gear without causing gear clash.

⚠ CAUTION ⚠

Keep brake squeeze close to the end of pedal stroke to assure that it will not be used as an upshifting brake and cause excessive brake wear.

Clutch Pedal Free Travel

NOTE: Proper clutch brake adjustment may in some instances conflict with the pedal free travel adjustment. In such cases the clutch brake adjustment should be maintained.

An acceptable range of clutch pedal free travel would be approximately 1-1/2-2 inches at the top of the pedal stroke. Part of this dimension is controlled by the bearing free travel at the release yoke and bearing (Figure 7).

NOTE: Lower than normal range of pedal free play as shown above, may indicate that a clutch adjustment is needed.

ADJUSTMENT PROCEDURES

Procedures for making the various clutch adjustments follow. Follow the procedures in order for items and dimensions in these procedures (Figures 6 & 7). If all other adjustments were within acceptable range before the clutch is installed, all adjustments should return to their correct setting when release travel is set.

NOTE: Never set the clutch release travel by the clutch actuating linkage.

Bearing Release Travel (Step 1)

NOTE: Make sure coach is in neutral with parking brake applied.

1. Remove clutch inspection plate.
2. Place a socket wrench on the engine pulley mounting nut. By turning the nut clockwise, the engine crankshaft can be rotated without loosening the nut and the clutch adjusting mechanism will be brought to the six o'clock position.
3. Check the clearance for the bearing release travel with the clutch engaged as shown in Figure 6. The measurement should be 1/2 to 9/16 inch between the clutch brake and the release bearing. If the

measurement is less than 1/2 inch or greater than 9/16 inch go on to step 4.

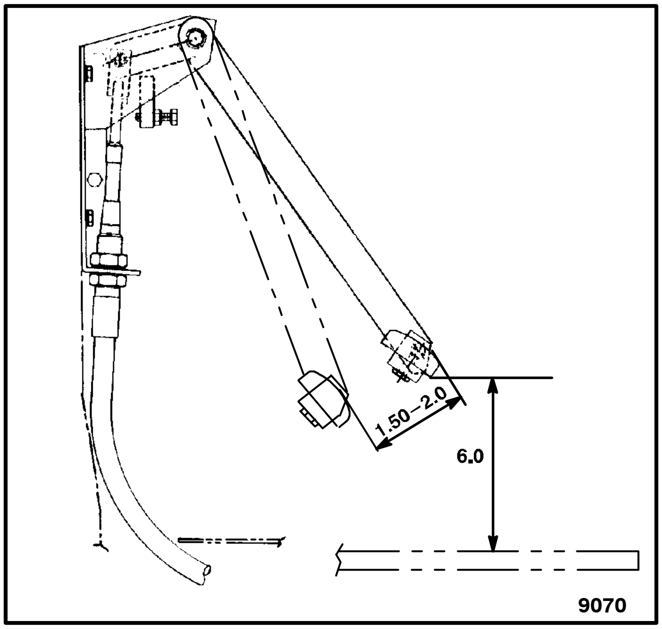


Figure 7. Pedal Free Travel

4. Release the clutch by depressing the clutch pedal, and place a 3/4 inch socket (12 point) or a 3/4 inch box-end wrench through the inspection hole and onto the square-headed bolt in the depressed area of the Kwik-Adjust™ mechanism (Figure 8).

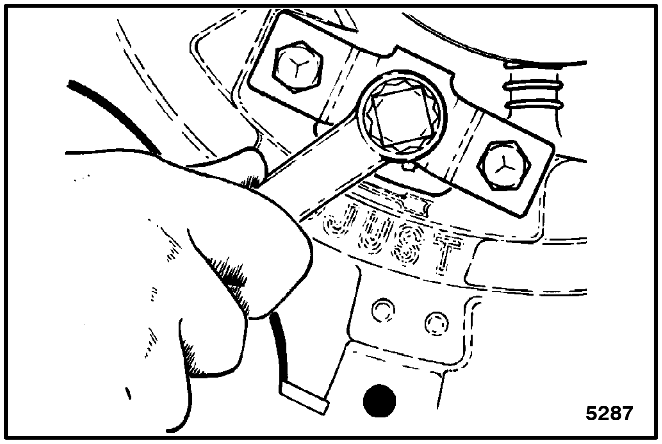


Figure 8. Release Travel Adjustment

5. Adjust the clearance by turning the Kwik-Adjust™ mechanism bolt. Check the release travel clearance after re-engaging the Kwik-Adjust™ mechanism and repeat if necessary.

NOTE: Turn the bolt clockwise to decrease release travel and counterclockwise to increase release travel.

NOTE: Kwik-Adjust™ will re-engage at a quarter turn of the flywheel.

6. Make sure that the mechanism has re-engaged and locked, and that the flat on the bolt head is aligned with the flat edge of the adjusting bracket.

7. Release clutch pedal and engage the clutch.

8. Check and set clutch free travel, and/or adjust clutch brake before re-attaching inspection plate.

Bearing Free Travel (Step 2)

1. Adjust the clutch free travel with the activating lever stop screw as shown in Figure 9.

NOTE: Clutch ree travel should be approximately 1/8 inch.

2. Check and/or adjust the clutch brake before re-attaching inspection plate.

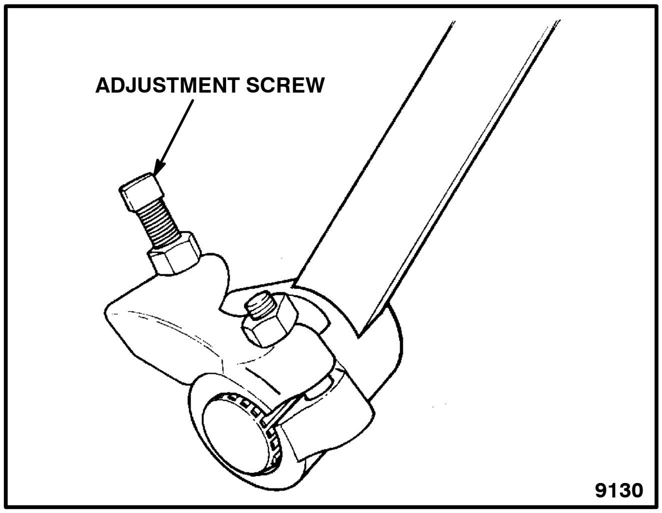


Figure 9. Brake Adjustment

Clutch Brake Squeeze (Step 3)

1. The torque-limiting clutch brake is also adjusted with the activating lever stop screw (Figure 9).

NOTE: Adjustment is very sensitive and should not affect free pedal travel more than 1/16 of an inch (1.6 mm). When correctly adjusted brake engagement should occur approximately 1/2 to 1 inch from the end of the pedal stroke.

NOTE: To check clutch brake insert a 0.10 inch feeler gauge between brake and release bearing and depress the pedal to squeeze gauge. Pull gauge while letting pedal up slowly, stop when feeler gauge can be pulled out and measure distance at pedal.

2. Re-attach clutch inspection cover.

Clutch Pedal Free Travel (Step 4)

NOTE: The clutch free pedal travel can be effected by adjustments to external linkage adjustments.

1. Check for correct pedal free travel after making internal/external clutch and linkage adjustments.

NOTE: The clutch pedal free travel should be approximately 1-1/2-2 inches when pedal is positioned at rest as shown in Figure 7.

NOTE: Normally, correcting bearing release and free travels will return the pedal free travel to correct adjustment.

2. Adjust yoke lever adjusting belt.
3. Unfasten front and rear control cables, attaching yoke to pedal and lever bracket assembly.
4. Adjust yoke/cable connection to make-up the correct free pedal travel measurement.
5. Refasten yoke to pedal assembly and recheck the measurement.

The clutch should be replaced when adjustment cannot correct slippage or loss of pedal free travel.

TRANSMISSION REMOVAL

Refer to Section 13 for the removal procedure on transmission.

CLUTCH REMOVAL

1. Install the spline aligning tool into the release bearing assembly and the driven discs (Figure 10). An old transmission input shaft may be used for this purpose, or tool number 20-40, shown on the tool page later in this section, may be purchased.

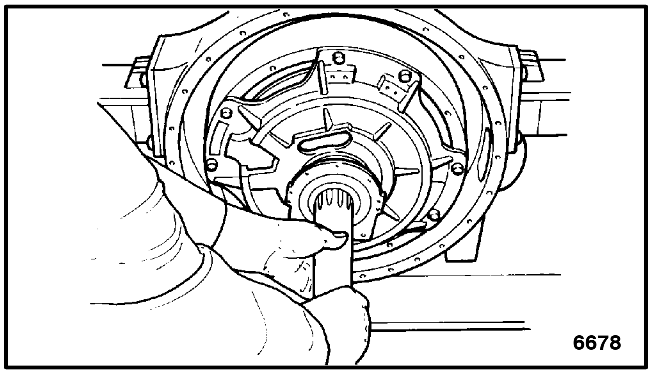


Figure 10. Spline Aligning Tool Installed

2. Insert two ⅝-inch spacers between the flywheel ring and the release bearing housing (Figure 11), then loosen the mounting bolts attaching clutch to flywheel. The spacers relieve the heavy internal spring load in the clutch assembly.

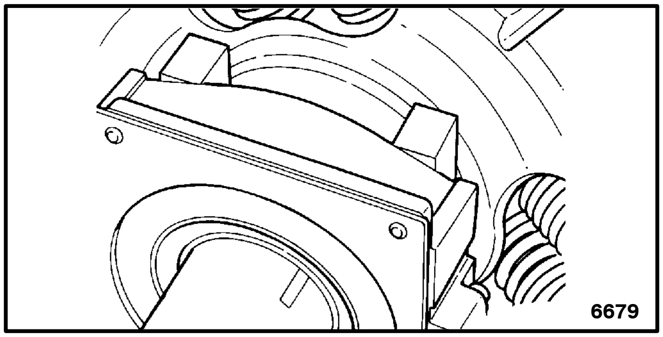


Figure 11. Wooden Blocks Installed Prior to Loosening Bolts

⚠ CAUTION ⚠

Be sure to loosen the mounting bolts in a criss-cross pattern to prevent cocking and bending within the clutch and ensure easy removal of the clutch mounting bolts.

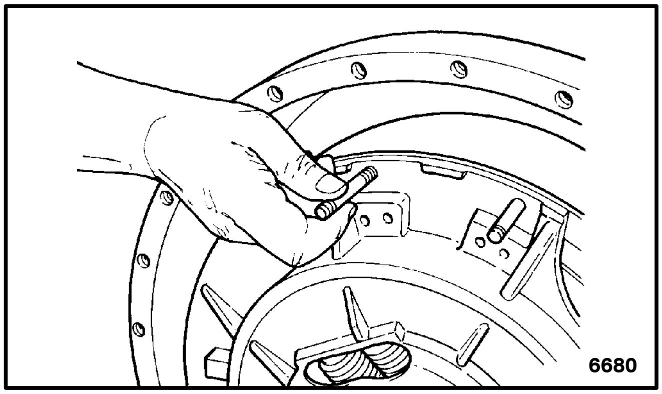


Figure 12. Installing Guide Studs

NOTE: Because of the weight of the clutch, install two guide studs in the top mounting bolt holes to facilitate removal (Figure 12). Then remove the mounting bolts and carefully remove the clutch assembly.

ENGINE & TRANSMISSION ALIGNMENT

Before installing a new clutch, ensure that the engine and transmission are lined up. To ensure their alignment, make the following checks or measurements. Surfaces being gauged or measured must be clean for accurate measurements.

Inspection

Inspect the mating faces of the transmission clutch housing and the engine flywheel housing (Figure 13). Any appreciable wear on the mating face of either housing will cause misalignment. Replace the housing if it is worn.

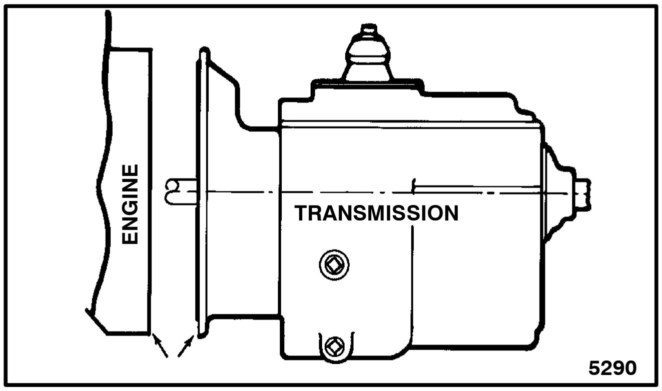


Figure 13. Inspect Transmission/Engine Mating Faces

Most wear will be found on the lower half of the facings between the 3 and 8 o'clock positions (Figure 14).

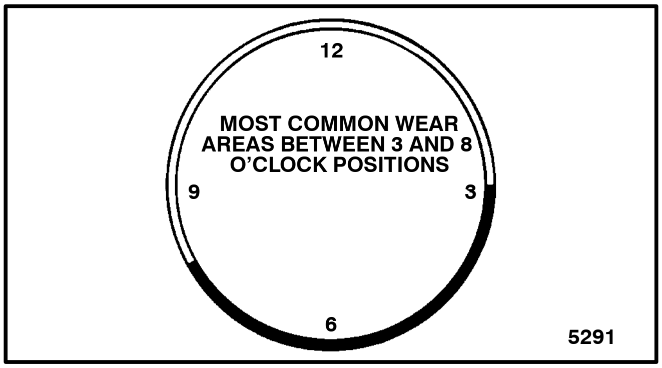


Figure 14. Common Wear Area

With a dial indicator attached to the engine flywheel or crankshaft (Figure 15) and the gauge finger against the housing pilot, rotate the flywheel by hand. With chalk or soapstone, mark the high and low points. The total indicated difference between the high and low points must not exceed 0.008 inch (0.203 mm).

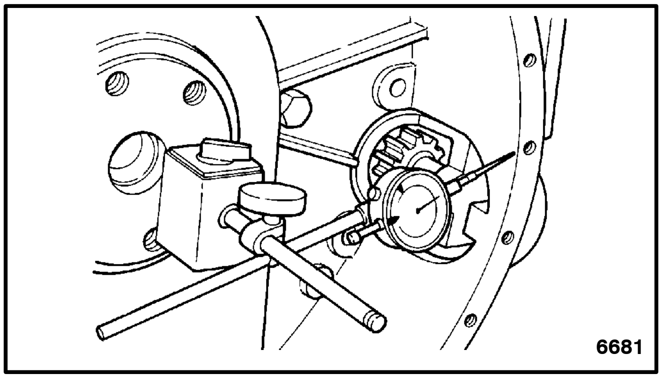


Figure 15. Dial Indicator Installed

Now move the gauge finger to contact the face of the engine flywheel housing (Figure 16). Rotate the flywheel and mark the high and low points. Total runout should not exceed 0.008 inch (0.203 mm).

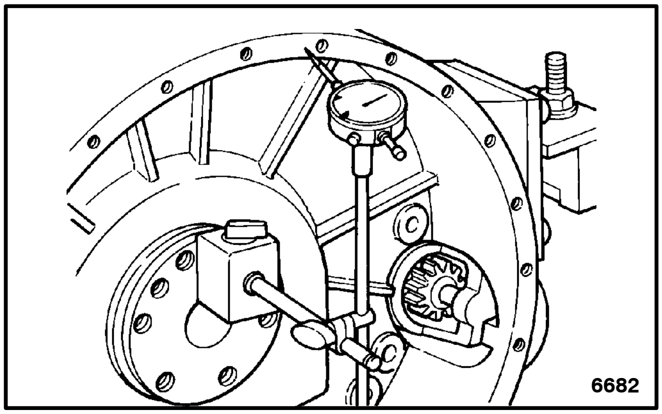


Figure 16. Gauge Finger at Face of Flywheel Housing

Next, secure the dial indicator to the engine flywheel housing with the gauge finger on the face of the flywheel near the outer edge. Rotate the flywheel. Maximum permissible runout is 0.0005-inch (0.0127 mm) per inch of flywheel diameter. In the case of the 15½ inch clutch used on the coach, the maximum permissible runout is 0.0775 inch (15½ inch x 0.0005).

Now move the gauge finger to contact the pilot bearing bore surface (Figure 17). Rotate the flywheel. The maximum total allowable runout is 0.005 inch. If any of these limits is exceeded, the problem must be corrected or misalignment will cause premature wear to the drive train components.

CLUTCH ASSEMBLY

1. Insert the spline aligning tool through the release bearing sleeve (Figure 18).

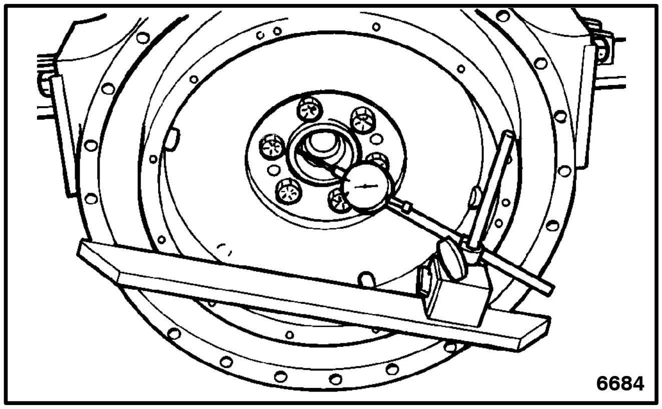


Figure 17. Gauge Finger at Pilot Bearing Bore Surface

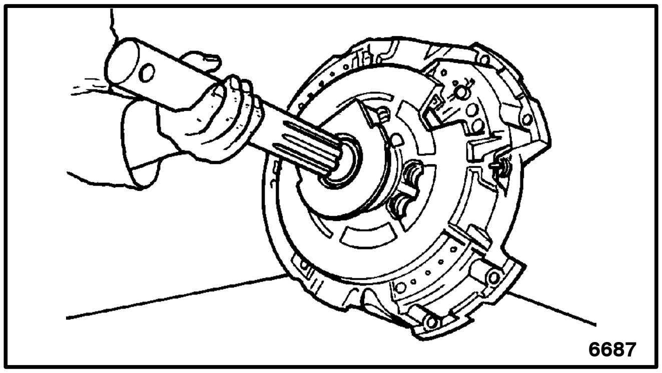


Figure 18. Inserting Alignment Tool in Release Bearing Sleeve

2. Then install the rear-driven disc on the tool with the side stamped “pressure plate” facing the pressure plate (Figure 19).

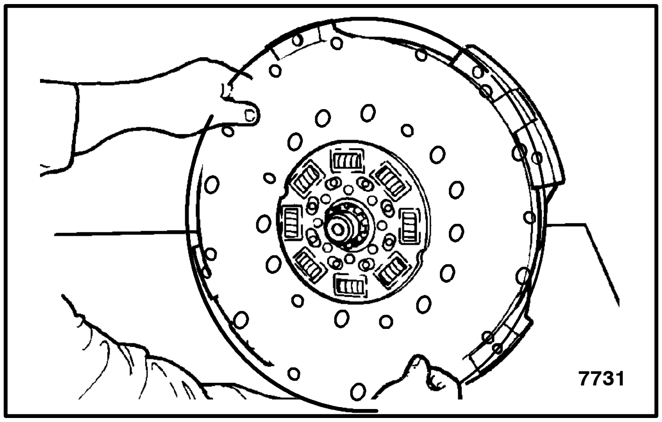


Figure 19. Installing Rear-Driven Disc

3. Place the intermediate plate in the clutch cover. Align the driving lugs of the plate with the slots provided (Figure 20). Position the plate so the pins set toward the flywheel side. The pins should be flush on the pressure plate side.

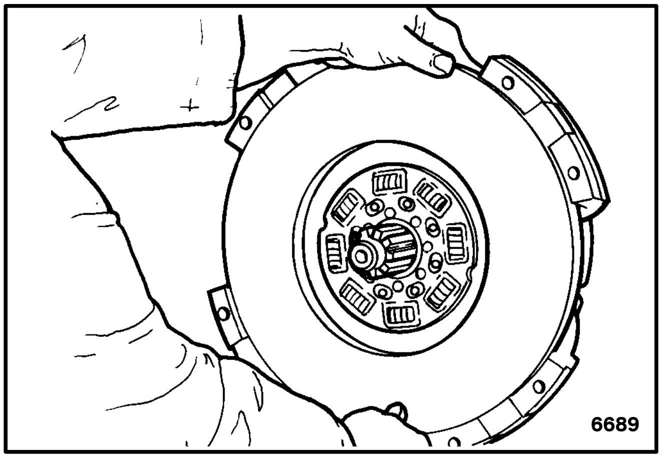


Figure 20. Placing Plate in Clutch Cover

4. Install the front-driven disc (Figure 21) on the aligning tool with the side stamped ”flywheel” facing the engine.

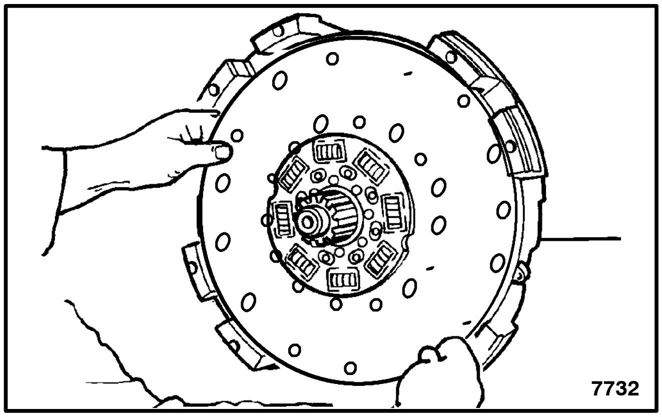


Figure 21. Installing Front-Driven Disc

5. Check clutch disc arrangement for correctness (Figure 22).

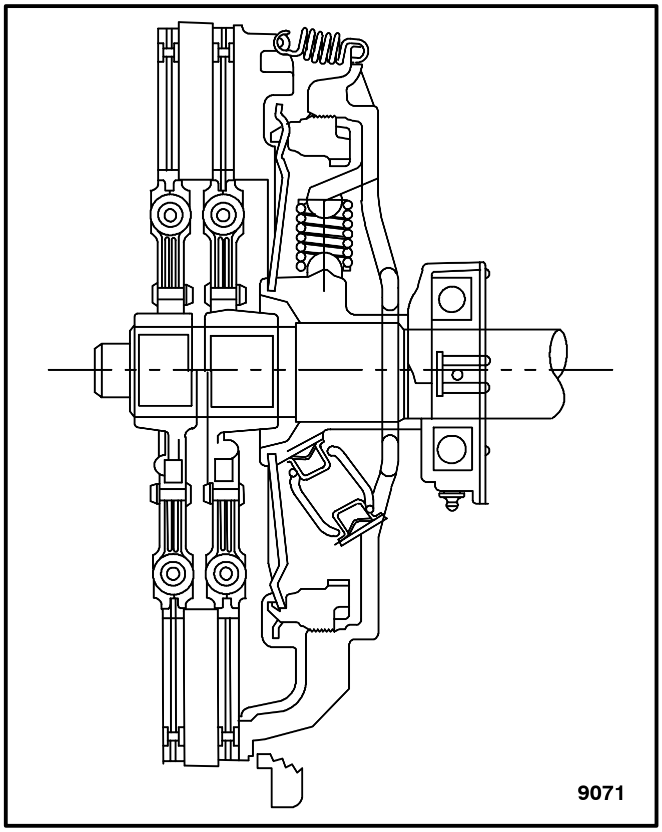


Figure 22. Clutch Disc Arrangement

CLUTCH INSTALLATION

1. Insert two 7/16 inch-14NC x 5 inch long guide studs into the two upper mounting holes of the flywheel (Figure 23). Rotate the flywheel to level the guide studs (Figure 24).

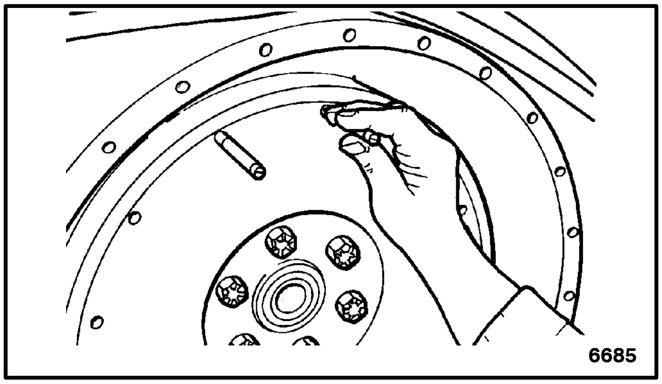


Figure 23. Inserting Guide Studs

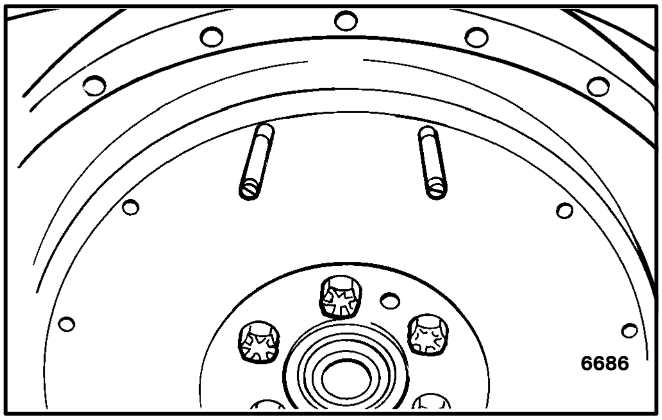


Figure 24. Leveling Guide Studs

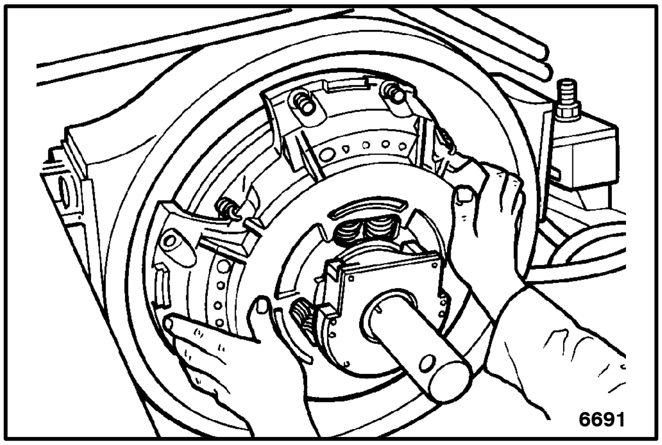


Figure 25. Positioning Clutch on Guide Studs

NOTE: It is not necessary to align the ceramic buttons on the front-driven disc with those on the rear-driven disc.

2. Position the clutch on the two guide studs (Figure 25) and slide the assembly forward until it starts in the flywheel pilot.

3. Start six $\frac{7}{16}$ inch-14NC (grade 5 or better) mounting bolts with lockwashers and turn in until they are finger tight (Figure 26).

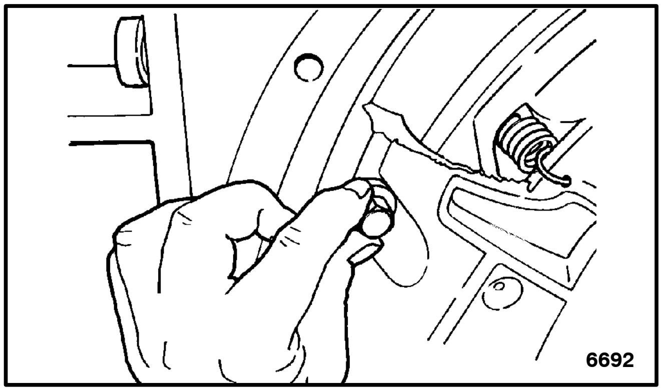


Figure 26. Starting Mounting Bolts

4. Tap the aligning tool to make sure it is centered and seated in the pilot bearing (Figure 27), then remove the two guide studs and replace them with $\frac{7}{16}$ inch bolts and lockwashers.

5. Tighten the 8 bolts progressively in the sequence shown (Figure 28).

⚠ CAUTION ⚠

If the bolts are not tightened in this sequence, permanent damage and an out of balance condition can result. The final torque for these bolts is 45-50 ft-lbs (61-68 N·m).

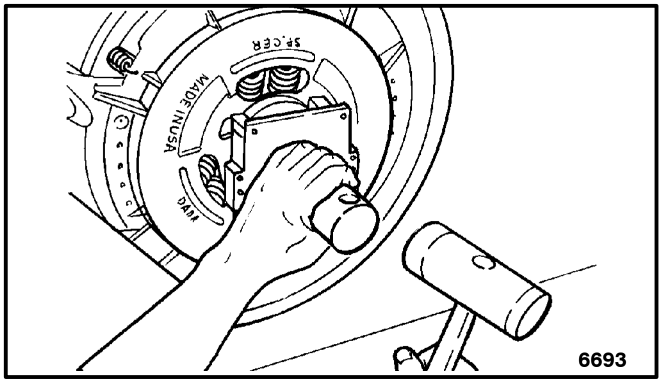


Figure 27. Centering Aligning Tool

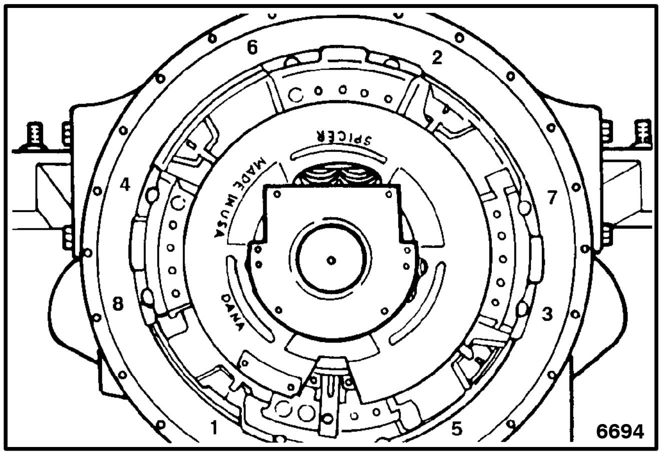


Figure 28. Correct Bolt Tightening Sequence

6. The separator pins must now be set against the flywheel. The pin access holes can be located by noting the arrows in (Figure 29).

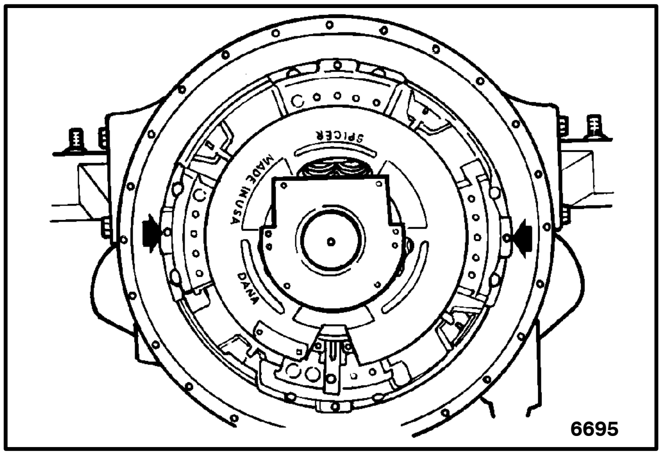


Figure 29. Pin Access Hole

7. Lightly tap each pin against the flywheel through the access holes using a 1/4 inch diameter flat-nosed drift (Figure 30).

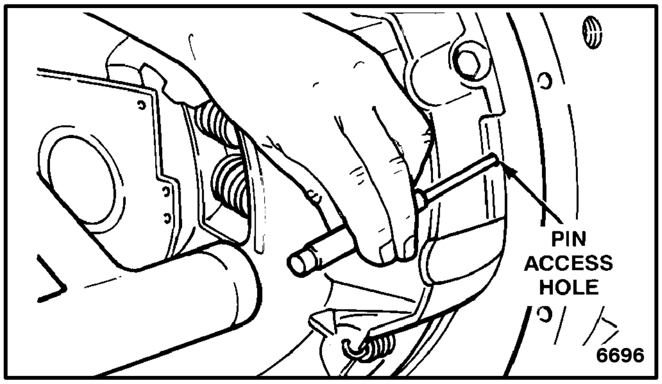


Figure 30. Setting Separator Holes

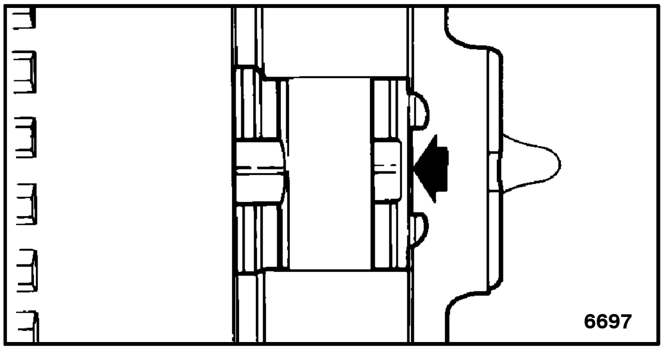


Figure 31. Separator Pin Installed

8. The pins should now be flush against the flywheel (Figure 31).

⚠ CAUTION ⚠

Safety glasses must be worn during this procedure.

The separator pin allows the intermediate plate to move back when the clutch is released giving a constant gap on both sides of the intermediate plate.

Position the clutch brake onto the input shaft of the transmission before installing clutch and release bearing (Figure 32).

YOKE TO BEARING INSTALLATION

1. Apply a light coating of anti-seize compound or high-temperature grease to the sides and bottom of the main drive gear splines. This will help prevent rust, fretting, corrosion, etc. while the clutch is in service and afford easier transmission removal at a later date. Spread a small amount of grease inside the clutch release bearing.

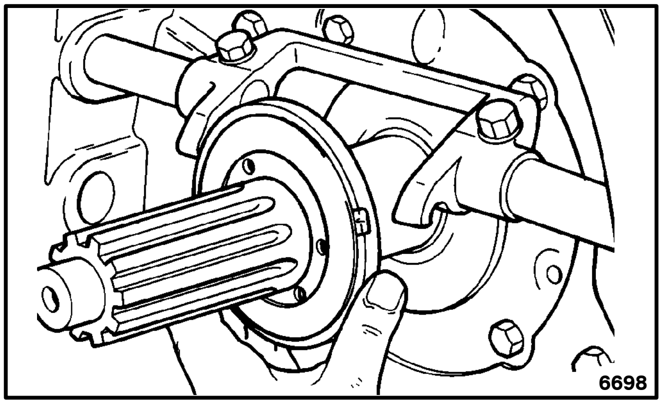


Figure 32. Installing Clutch Brake

CAUTION

Avoid the common practice of smearing a handful of grease over the splines of the drive gear. Most of this grease will be wiped off by the release bearing sleeve when the trans mission is assembled to the clutch.

2. Always check wear on clutch release yoke fingers and replace the yoke if necessary.

3. Shift transmission into gear so that the main drive gear can be rotated during assembly to align with clutch-driven disc hub splines.

4. Rotate clutch release bearing housing so that flat section is on top. If cross shaft is below center, rotate bearing housing 180 degrees.

NOTE: Use a suitable sling or transmission jack to properly support and maintain engine/transmission alignment when installing the transmission.

NOTE: Use care to avoid hanging the weight of the transmission on the clutch or forcing the transmission into the clutch/flywheel housing.

5. Rotate the clutch release yoke (CR-7) so that release yoke fingers clear the pads on the release bearing housing. Center the yoke on drive gear bearing cap. Yoke must be held in this position during early part of assembly. Enter main drive gear into clutch release bearing sleeve (H-1). Rotate clutch release yoke into proper position as the transmission is moved into place. Slide transmission forward slowly to pick up driven disc splined hubs. It may be necessary to rotate companion flange slowly to align the splines of drive gear and clutch discs (Figure 33).

6. Observing through handhole opening in bell housing, make certain release bearing assembly is vertical with flat section on top and clutch release yoke fingers tipped up and centered to pass over release pads of release bearing assembly (Figure 34).

CAUTION

Use care to avoid springing the driven discs when the transmission is being installed. Do not force the transmission into the clutch or flywheel housing if it resists. Don't let the transmission drop or hang unsupported by the driven discs.

7. As soon as the fingers of the clutch release yoke pass the thrust pads of release bearing assembly, turn the release shaft to swing the yoke fingers down in front of release pads (Figure 35).

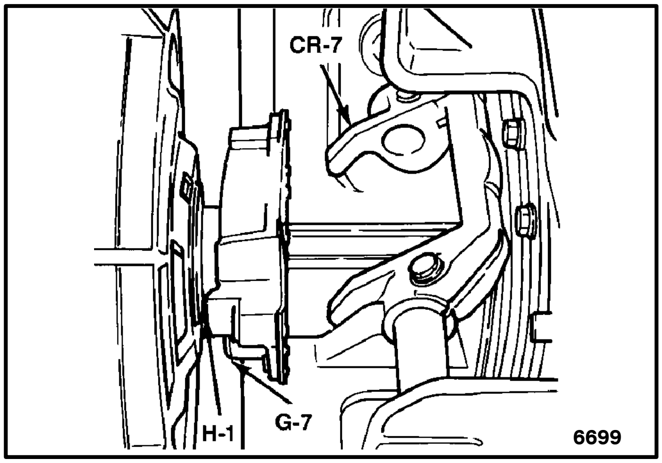


Figure 33. Yoke Position

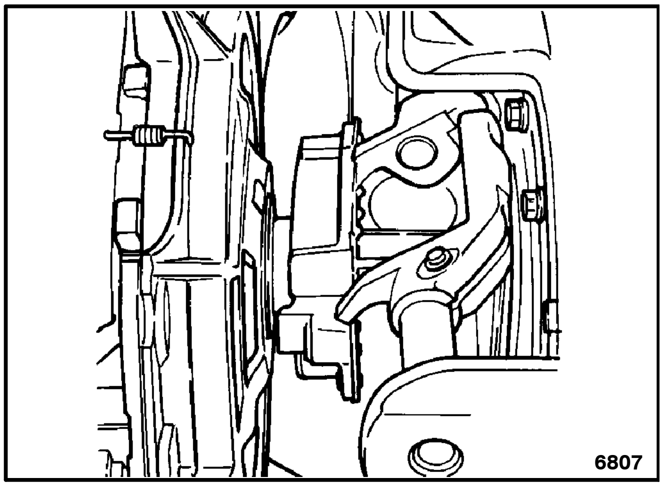


Figure 34. Check Release Bearing Assembly

8. Enter pilot of clutch housing into flywheel housing and align capscrew holes. Start all capscrews and tighten progressively around housing.

9. Connect clutch release linkage and check for proper free pedal, release bearing travel, clutch brake squeeze, etc., as outlined under clutch adjustment.

10. Readjust clutch and linkage, if required at this time. If new clutch facings were installed, it may be necessary to readjust clutch shortly after clutch is placed in service.

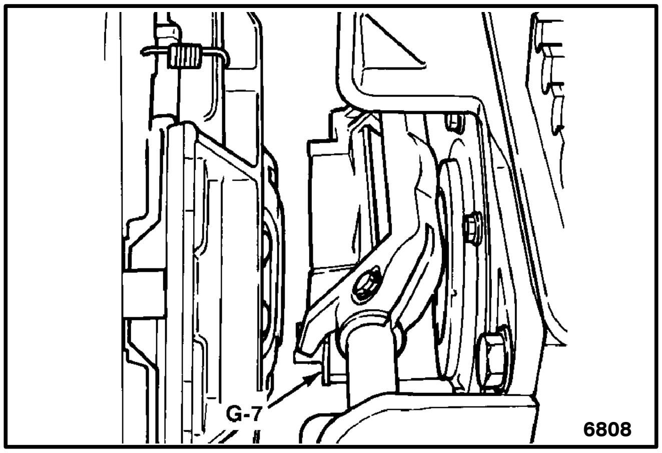


Figure 35. Swing Yoke Fingers Down

NOTE: Interference with release yoke fingers by the clutch flywheel ring will prevent assembly of transmission or cause binding of release shaft if it is not rotated as shown in Figures 30 thru 32 (areas G-7).

CLUTCH LIFE REMAINING

Many clutches are replaced as a preventive maintenance item at low mileage during repairs of the transmission or engine. Before the clutch assembly is replaced, it should be inspected for the following:

A. Heat cracks in the pressure plate.
B. Excessive wear in all drive slots.
C. Broken springs.
D. Dry or damaged release bearing.
E. Broken intermediate plate.
F. Excessive driven disc hub spline wear.
G. Burned facings.
H. Excessive wear on drive pins or intermediate plate slots.

If any of the above are not observed, the following graph (Figure 36) can be applied to determine the approximate remaining clutch life by measuring the thickness of the rear-driven disc assembly.

Find thickness of rear disc on column at left, then follow to curve on right and down to read percent of clutch life remaining.

Helpful Hints to Operate Vehicles With Ceramic Clutch Facings

1. Driver must start vehicle in first gear.
2. Ceramic facings slip-period is shorter than organic facings.
3. While operating a ceramic clutch the driver has to engage the clutch before giving the engine any fuel (engine at idle).,
4. If driver tries to slip ceramic clutch facings by raising R.P.M.'s with accelerator and riding or feathering clutch pedal, the vehicle will experience erratic engagement.

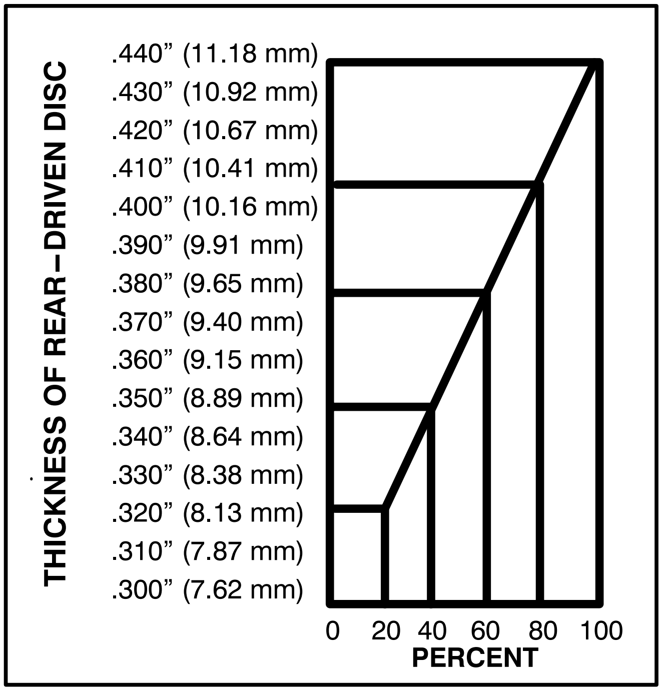


Figure 36. Percent of Clutch Life Remaining

TROUBLESHOOTING

TROUBLE	CORRECTION
TOO MUCH FREE PEDAL	a. Check linkage for too much release travel.
NO FREE PEDAL	a. Ball not in retainer hole. b. Broken or weak pedal return spring. c. Adjusting spring not free to rotate. d. Defective adjuster assembly. e. Check release travel - must be ½” (12.7 mm) plus about ⅛” (3.175 mm) free travel. Short travel linkage will not work with this mechanism. f. Clutch brake adjusted too high. Should be adjusted 1” (25.4 mm) from end of pedal stroke. g. Total clutch adjustment has been taken up. (Remove and replace clutch.)
POOR RELEASE 1. Pressure plate not retracting.	a. Check pressure plate drive lugs for proper clearance of .006” min. (.152 mm). b. Pressure plate return springs are bent or stretched. Check for proper tension. c. Replace if necessary. d. Insufficient release travel. e. Lever nose out of groove in release sleeve retainer.
2. Driven disc distorted or warped.	a. Driven disc assembly must be straight within .015” (.381 mm) total indicator reading. Replace discs if they cannot be straightened. b. Damage to driven discs can be caused by poor installation methods. Do not force transmission drive gear into disc hubs. This will distort or bend driven discs causing poor release.
3. Splines worn on main drive gear of transmission.	a. Replace drive gear and check driven disc hubs for excessive wear. If worn, replace disc. Check flywheel housing alignment of engine and transmission. Make sure driven discs slide freely on drive gear splines. b. Check pressure plate drive lugs for proper clearance of .006” min. (.152 mm).
4. Internal clutch adjustment not correct.	a. Readjust clutch for standard release travel. Refer to adjusting instruction. b. Proper clutch adjustment must be maintained for proper clutch release.
5. Flywheel pilot bearing fitting too tightly in flywheel or on end of drive gear.	a. Free pilot bearing to a light push. b. Fit in flywheel and on drive gear pilot. c. If gearing is rough, replace.
6. Facings gummed with oil or grease.	a. Replace facings or entire driven disc assembly. b. Cleaning not recommended.
7. Damaged clutch release bearing.	a. Replace bearing. b. If bearing is grease type, lubricate.
8. Clutch release shaft projecting through release yoke.	a. Relocate shaft so it does not project. b. Check all housing bushings and release yoke for wear.
9. Release yoke contacting cover assembly at full release position.	a. Replace release yoke with proper yoke.

TROUBLESHOOTING (Contd.)

TROUBLE	CORRECTION
10. Release yoke will not align with release bearing properly.	a. Flywheel has been resurfaced more than recommended .060” (1.524 mm) removal.
11. Broken intermediate plate.	a. Replace entire intermediate plate/driver disc assembly. Cause abusive use of clutch.
CLUTCH SLIPPAGE 1. Weak pressure springs.	a. Replace springs.
2. No free pedal.	a. Readjust clutch. b. Refer to adjustment instructions.
3. Clutch adjustment not correct	a. Readjust clutch.
NOISY CLUTCH 1. Clutch release bearings dry or damaged.	a. Lubricate bearing or replace.
2. Flywheel pilot bearing dry or damaged.	a. Lubricate bearing or replace.
3. Clutch release bearing housing striking flywheel ring.	a. Adjust clutch. b. Refer to adjustment instructions. c. Also check wear on cross shafts, bell housing bushings and release yoke
4. Excessive clearance between drive slots and drive lugs on intermediate and pressure plates.	a. Check clearance as noted on wear limits. If above limits, replace parts.
5. Worn clutch facings.	a. Replace facings or complete driven disc assembly.
6. Release mechanism binds.	a. Free up mechanism and linkage, check clutch adjustment. b. Refer to adjustment instructions. c. Lube if necessary.
7. Grease or oil on facings.	a. Replace facings or complete driven disc assembly.
8. Overloaded clutch	a. Ensure that proper clutch has been specified.
WEAR COMPENSATOR DOES NOT MAINTAIN ADJUSTMENT 1. Improper linkage adjustment.	a. Re-adjust per instructions.
2. Not using full pedal travel.	a. Use full pedal travel when shifting into 1st. & reverse.
3. Adjuster ball not in hole in retainer.	a. Insert ball into retainer lug hole.
4. Ball lever spring loose on barrel.	a. Replace adjuster assy.
5. Ball loose on lever spring.	a. Replace adjuster assy.
6. Lever spring broken off.	a. Replace adjuster assy.
7. Frozen adjuster assy.	a. Replace adjuster assy.
8. Lever spring wrapped up. (too short)	a. Replace adjuster assy.
9. Frozen adjusting ring.	a. Free up adjusting ring or replace clutch assy.
10. Clutch will not stay in adjustment.	a. Make sure worm gear is fully engaged in adjusting ring teeth.
WEAR COMPENSATOR OVER ADJUSTING 1. Improper linkage adjustment.	a. Re-adjust per instructions.
2. Over 1/2” release bearing travel.	a. Re-adjust per instructions.
3. Holding spring broken.	a. Replace adjuster assy.

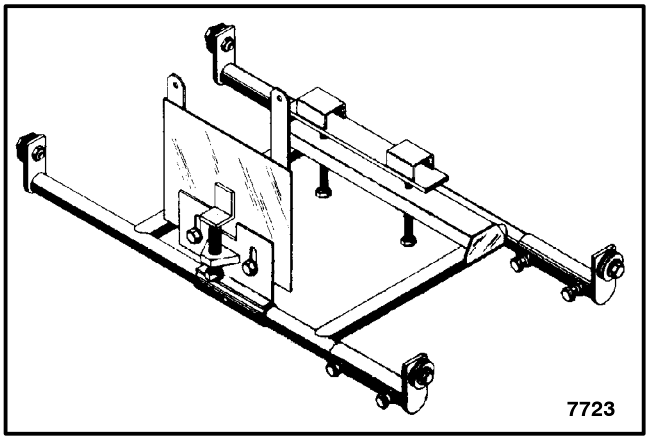
SPECIFICATIONS

CLUTCH ASSEMBLY

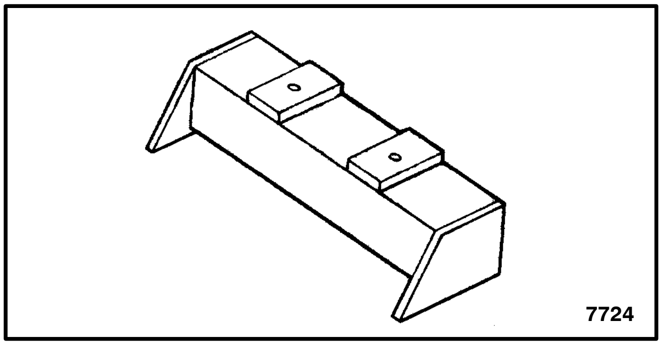
Manufacturer	Dana/Spicer
Part Number	(2800 lbs. Organic) 5L-1-2
Part Number	(3200 lbs. Organic) 5L-1-1
Part Number	(3600 lbs. Organic) 5L-1-63
Design	2-Plate (Dampered)
Release Style	Pulled Type
Size	15-1/2”
Organic Facing Thickness - Standard	0.455/0.445” (11.56-11.30 mm)
Hub Spline Size (inches)	1#@4-10
Number of Splines	2-10
Disc Assembly Max. Runout (T.I.R.)	.015” (.381 mm)
Disc Assembly Max. Out of Flat	.020” (.508 mm)
Release Sleeve	1.754/1.750” (44.552/44.45 mm)
Bushing Diameter (new)	2.010/2.008” (51.054/51.003 mm)
Intermediate Plates, driving lugs to slot clearance (new, min.)	0.006” (0.152 mm)
Intermediate Plates, driving lugs to slot clearance (max. worn)	0.015” to 0.021” (0.381 mm to 0.533 mm)
Pressure Plates, driving lugs to slot clearance (new)	.003” to 0.010” (0.076 to 0.254 mm)
Pressure Plates, driving lugs to slot clearance (max. worn)	0.016” to 0.021” (0.406 to 0.533 mm)
Intermediate Plates and Pressure Plates: Out-of-Flat	.000 to 0.004” (0.000 to 0.102 mm) Concave
Scoring - Max. depth that can be reused	0.015” (0.381 mm)
Release Sleeve Retainer, driving lugs to slot clearance (max. worn)	0.020” (0.508 mm)
Maximum Engine RPM	2600

SERVICE TOOLS

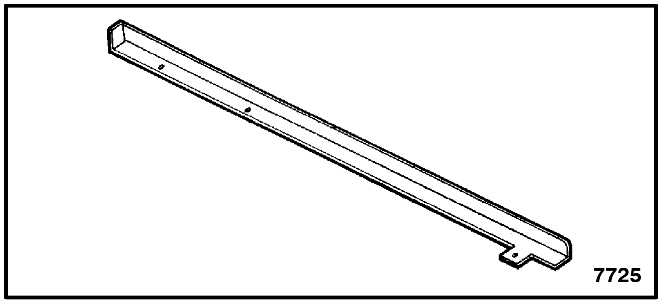
SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20-233 Transmission Dolly (For 3-Axle Coach Only)

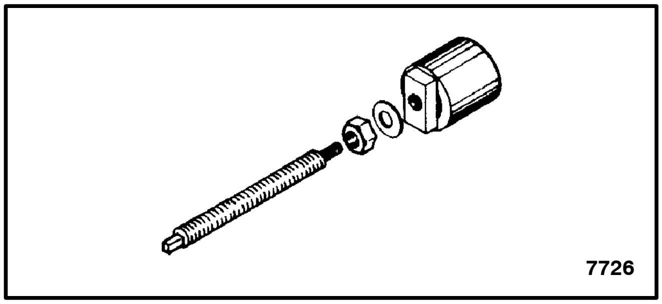


20-234 Transmission Adjusting Channel (For 20-233 Dolly)

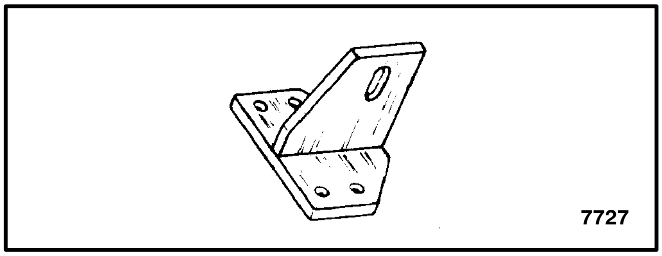


20-235 Support Rail - LH. - For 20-333 Transmission Dolly

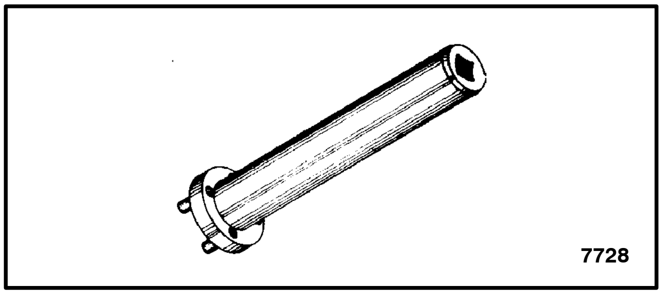
20-236 Support Rail - RH. - For 20-333 Transmission Dolly



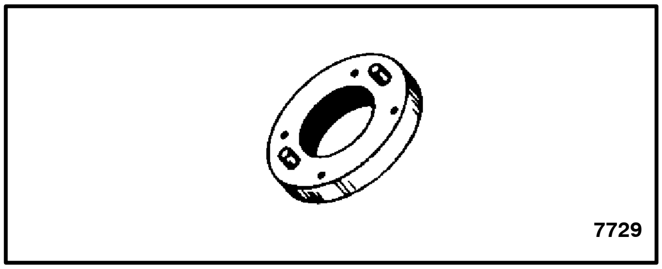
20-42 Puller - Removing Transmission Reverse Idler Gear Shaft



20-57 Lifter Plate Assembly - Allison Transmission



20-43 Wrench - Assembling Bearing Retaining Nut on Transmission Main Drive Gear (use with 20-79)



20-79 Adapter - Transmission Drive Gear, Lock Nut Installation Tool

NOTE: The special tools required for servicing either the electronically or non-electronically controlled automatic transmission are listed in the appropriate Detroit Diesel Allison.

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 6

COOLING

This section consists of five primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The five primary subsections are:

A1 - Radiator Module Assembly - 8V-92TA Engine
A2 - Radiator & Charge-Air Module - Series 60 Engine Installations
(Used Prior to 102DL3 Unit 45959)
A3 - Radiator & Charge-Air Module -
Series 60, Caterpillar & Cummins Engine Installations
(Effective with Unit 45959)
B - Cooling System Components (Typical)
C - Coolant

SECTION 6A1

RADIATOR MODULE ASSEMBLY (8V-92TA ENGINE)

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 6A1-1
Components 6A1-1
Maintenance 6A1-4
Service Tools 6A1-21
Specifications 6A1-21

GENERAL DESCRIPTION

The radiator module is one of the major components of the engine's cooling system. The module (Figure 1) is composed of a radiator assembly, air controlled shutter and fan clutch system, and mounting frame. The heat-dissipating capacity of the radiator assembly along with the fan control system should prevent the 8V-92 engine coolant temperature from rising above the maximum allowable limit of 210°F (98°C).

> **NOTE:** This temperature must not be exceeded under any engine operating conditions, regardless of altitude, type of coolant used, or cooling system condition. Exceeding these limits could result in power-down safety sequence initiation, engine malfunction and/or serious damage.

As coolant circulates through the engine it gathers heat from the combustion process. The engine thermostats release coolant, through the engine compartment's piping network, to the radiator module where a heat transfer process takes place. The system uses air drawn over the radiator's finned tubes to achieve this process and reduce the coolant's temperature. Dual fans pull air across the radiator through louvered panels at the rear side of coach, and radially expel it out the rear radiator door.

The 8V-92 engine cooling system consists of several components working in conjunction to maintain a safe engine operating temperature. When activated, the engine's cooling system is also utilized to heat the passenger and driver areas of the coach (see Section 16). Coolant for this function is taken, by the collector pipe, off both sides of the engine block, and routed to the center tunnel piping system. Coolant is returned to the engine's water pump inlet after completing heating circuit.

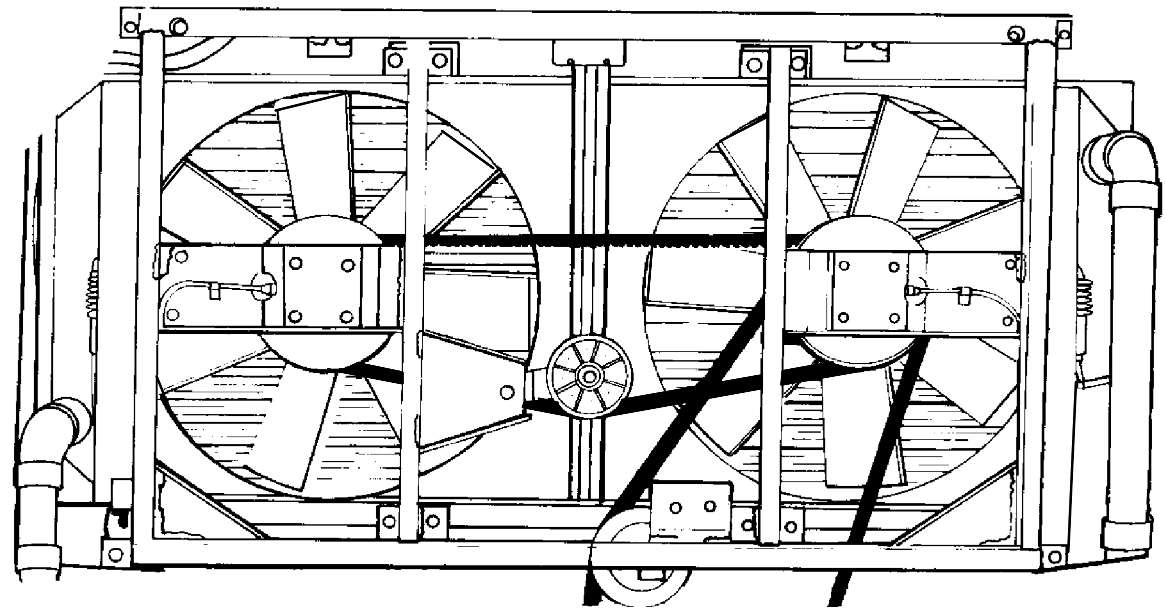
COMPONENTS

RADIATOR ASSEMBLY

The radiator assembly is composed of two separate radiator cores, headers and reservoirs. The radiators are joined header-to-header and form a large common header, with vertical reservoirs on either side. The radiator core design is a finned tube cross-flow type. Coolant flow is from right (inlet) to left (outlet), and maintained by the engine's water pump and system pressure. The radiator assembly is fitted with fan shutters and shrouds, and installed on the radiator module with air blocking foam seals.

MODULE FRAME ASSEMBLY

The module is located at the upper rear of the coach above the engine and below the coolant surge tank. Carbon steel construction is basic on the standard module support frame, while stainless steel construction is optional for corrosion resistance. The module is attached by fasteners to the coach's rear upper frame, and can be removed as a unit.



LEFT–HAND FAN CLUTCH
RIGHT–HAND FAN CLUTCH
SHUTTERS
SHUTTER CONTROL CYLINDERS

MODULE FRAME
FAN DRIVE BELT
FAN DRIVE BELT TENSIONING PULLEY
FAN CLUTCH TO CLUTCH BELT
FAN CLUTCH BELT TENSIONING PULLEY

Figure 1. Radiator Module

CLUTCH FAN ASSEMBLY

The radiator module is fitted with twin air-operated coolant temperature activated fan clutches, each mounting a thirty-inch seven-bladed reinforced nylon fan. The clutch is an air-engaged piston-to-friction plate design. The primary (left) cooling fan clutch engages at 180°F, and the secondary (right) cooling fan clutch engages at 190°F (Figure 2). Fan clutch application air is applied just after the shutter opens, and exhausted shortly after shutters begin to close.

At engine operating temperature the fan clutch control system routes air to primary fan only, or to both fans, depending on coolant temperature. The secondary fan clutch may cycle on and off. The control system maximizes the fan's ability to draw cool air across the radiator assembly, while using the minimum amount of horsepower. The automatic function of the fans may be tested or by-passed by activating the appropriate test switch at module's lower right corner.

The primary fan is driven by a single belt from the engine crankshaft pulley. The secondary fan is single belt driven by the primary fan clutch pulley. Both belt drives incorporate a tensioning device and pulley assembly mounted to the module frame.

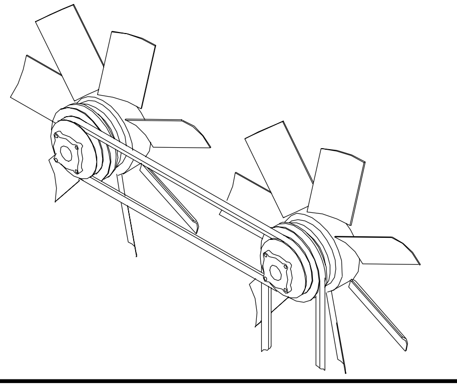


Figure 2. Fan Clutch

SHUTTER ASSEMBLY

Two air-operated spring return shutter assemblies are mounted to the radiator assembly on the exhaust side. Each shutter assembly is independently operated by its own single-acting air cylinder (Figure 3). The actuation of the shutter cylinders is determined by the shutter control system. When air is applied to the normally open shutter assembly, it closes. When de-activated, shutter closure begins before the air clutch is disengaged, so that fan pressure dampens spring-loaded shutter closure. When closed by manual switch, the shutter (right hand only) allows fan-to-engine belt maintenance to be performed.

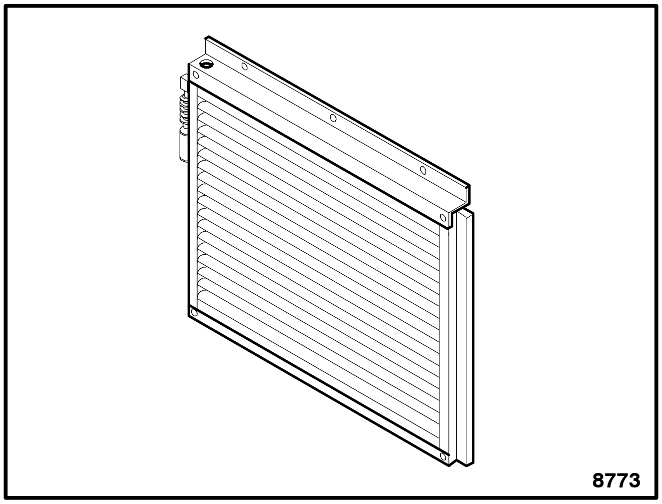


Figure 3. Shutters

AIR CONTROLS

The air control system for the fan clutches and shutters automatically monitors and reacts to temperature changes within the engine-to-radiator coolant inlet tube. The control system allows for either the primary fan and shutter to be actuated or primary and secondary together if required. Additionally, the system features manually operated fan/shutter test/by-pass and shutter close functions. System air is supplied through an air filter assembly.

The control system components include a 180°F (left) and a 190°F (right) shutterstat, two (2) inversion valves and three (3) air switches. The normally open shutterstats mount to radiator inlet tube ten inches apart in-line, with the right hand stat in bottom location. The normally open inversion valves are mounted to the lower right side of module, and plumbed through the manually-operated switching array. The air-diverting toggle switches are mounted to a plate at the lower right front of the module.

At cold engine starting, the inversion valve's pilot port is pressurized, air from the inversion valve supply port is blocked, and the valve exhausts fan clutch to atmosphere (Figure 4). The air control system's design maximizes the module's ability to transfer heat, while using the minimum amount of horsepower.

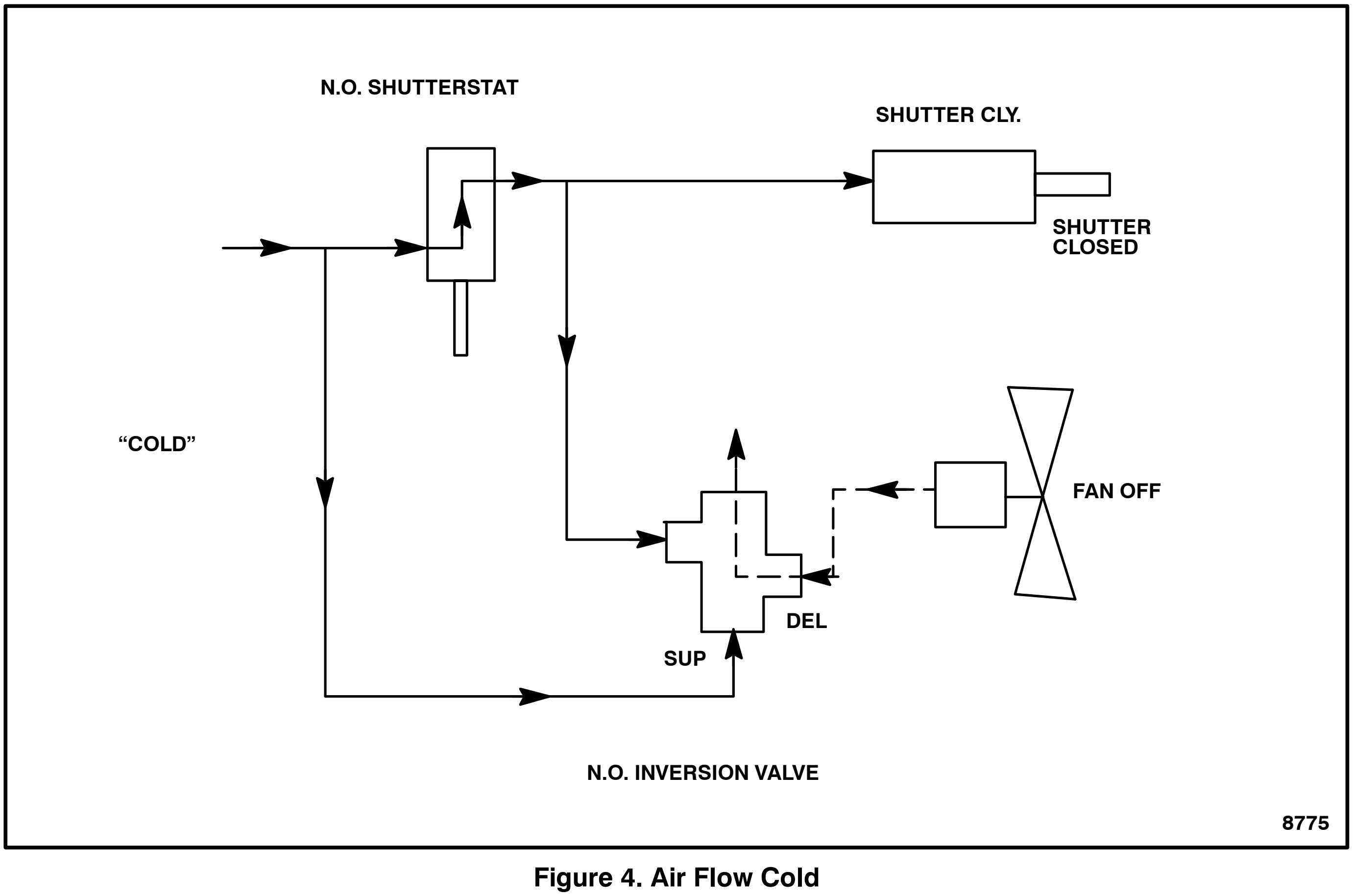


Figure 4. Air Flow Cold

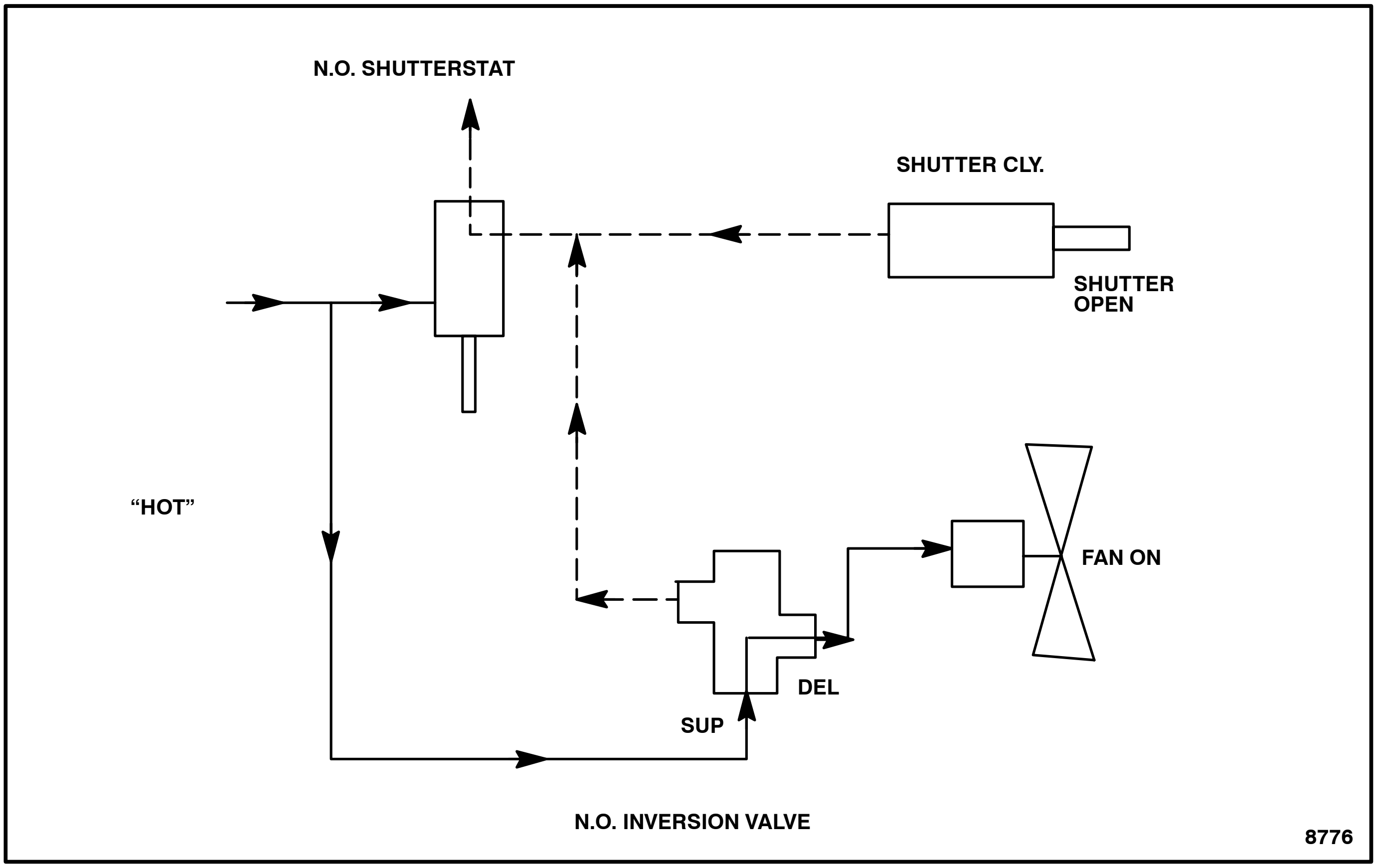


Figure 5. Air Flow Hot

As engine reaches stat's operating temperature of 180°F (Figure 5), the left hand shutterstat should close, cutting air flow to the shutter cylinder and pilot port of the inversion valve. This allows the shutter cylinder and inversion valve pilot port lines to exhaust through the shutterstat, opening the shutter and the inversion valve supply-to-delivery port path, allowing inversion valve air supply to activate clutch. At 190°F the sequence is repeated for the right hand components.

NOTE: If a low air situation or a complete loss of air pressure exists on the coach at engine start-up, the module's air control system may briefly exhibit some fan clutch engagement/disengagement and shutter function until coach air system fills to operating pressure.

MAINTENANCE

FAN DRIVE BELT ADJUSTMENTS

Proper belt tension must be maintained on the engine-to-fan and fan-to-fan drive belts. Belts should be tensioned to the deflections shown (Figure 6) when force shown is applied at mid-span.

To adjust tension loosen hex head capscrew mounting tensioner assembly. Apply pressure to the belt by rotating tensioner assembly into the belt using a wrench on the 2 inch square of the tensioner base. When belt is properly tensioned, tighten the mounting bolt while holding the tensioner assembly in place. Mounting bolt torque should be 55-65 ft-lbs (74.6-88.1 N·m).

ENGINE-TO-FAN BELT REMOVAL

1. Loosen belt tensioner assembly.
2. Remove belt from sheave on engine crank pulley.
3. Close right hand shutter on radiator using the switch located on module frame.
4. Slide belt between the fan and closed shutter, using the notch located in the lower left-hand corner of the fan shroud to help work belt around fan blade.

INSTALLATION

Install belt by reversing procedure. When installing a new belt check and retension belt after 200 miles of operation and again at 2,000 miles of operation using "BELT ADJUSTMENT" procedure described earlier.

FAN-TO-FAN BELT REMOVAL

1. Loosen the belt tensioner assembly and remove the engine-to-fan belt from the engine drive pulley.

2. Loosen the tensioner on the fan-to-fan drive belt and remove.

3. Remove left-hand fan, clutch and frame assembly (see “RADIATOR MODULE DISASSEMBLY”).

4. Remove belt from the right-hand fan assembly using same procedure used to remove engine-to-fan drive belt.

INSTALLATION

1. Reverse procedure to install new fan-to-fan belt.

2. Reinstall fan frame assembly, See “RADIATOR MODULE ASSEMBLY” for proper assembly steps.

3. Tension belt to proper specification and recheck tension after 200 miles and 2000 miles of operation.

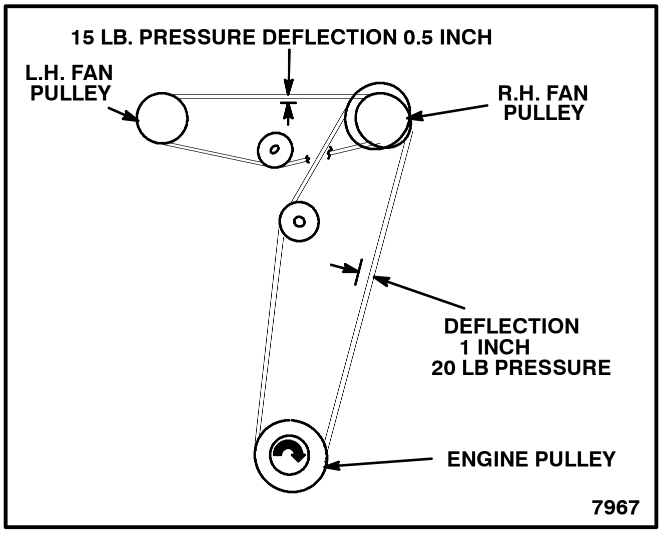

15 LB. PRESSURE DEFLECTION 0.5 INCH
L.H. FAN PULLEY
R.H. FAN PULLEY
DEFLECTION 1 INCH 20 LB PRESSURE
ENGINE PULLEY
7967

Figure 6. Drive Belt Tensioning

CLUTCH FAN ASSEMBLY

The air-actuated clutch mechanism on the Horton Diesltemp® requires some periodic maintenance (Figure 7). Every 25,000 miles (40,225 km) the clutch air chamber should be inspected for air leakage. If leaks are found follow the procedure for “O-ring and Face Seal Replacement”. Additionally, it’s recommended that every 350,000 miles (563,150 km) the procedure for “Major Overhaul” should be performed. Follow all procedures in the order in which they appear.

Clutch Fan Removal

1. Follow procedure for primary or secondary drive belt removals.

2. Unfasten and remove the clutch fan and mounting bracket assembly from module frame.

3. Unfasten and remove the clutch and fan assembly from mounting bracket.

4. Unfasten and remove nylon fan blade from clutch mounting hub.

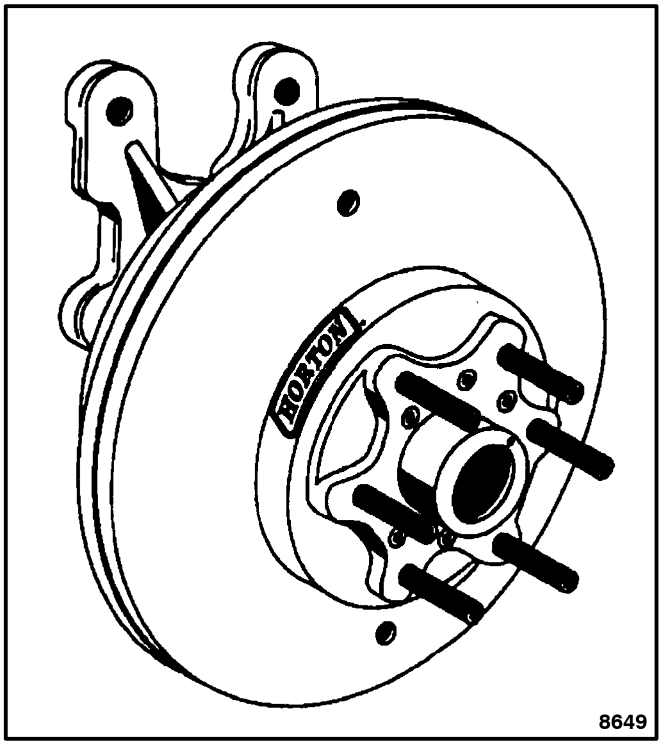


Figure 7. Clutch Mechanism

Clutch Disassembly

1. Clamp fan clutch in vise.

2. Remove socket head fasteners from air chamber (Figure 8).

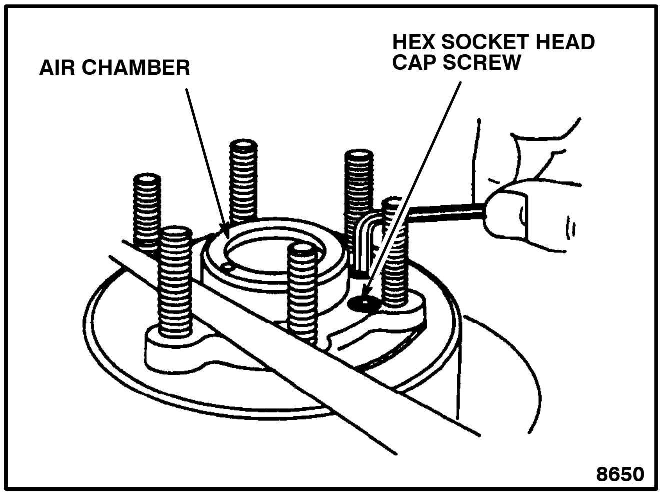


Figure 8. Clutch and Air Chamber Removal

NOTE: Applying air pressure to clutch aids in removal of air chamber assembly from clutch. Attention must be exercised when using this procedure to prevent air chamber from popping off, resulting in personal injury.

3. Slide air chamber assembly off piston/friction disc.

4. Examine air chamber for signs of dirt or foreign matter.

⚠ CAUTION ⚠

Air chamber should be clean and dry. If not, a problem exists in the vehicle air system, and must be corrected before fan clutch is reinstalled. See "Shutterstat Filter" later in this section.

O-ring and Face Seal Replacement

1. Remove O-ring from air chamber and clean O-ring contact surfaces (Figure 9).

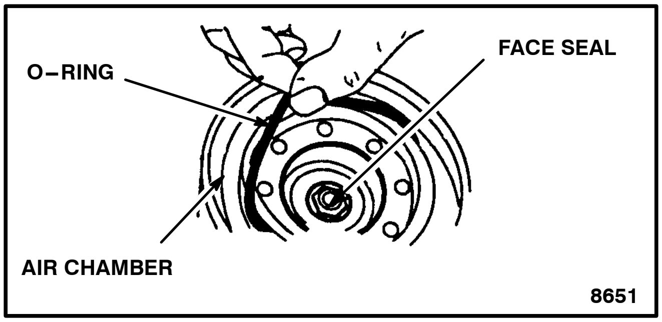


Figure 9. Small O-ring Removal

2. Remove and inspect face seal for signs of wear that may indicate dirt exists in air system.

3. Remove piston/friction disc and clean splines of both the friction disc and hub (Figure 10).

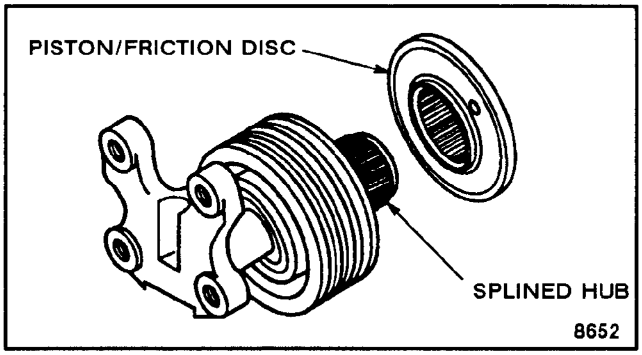


Figure 10. Friction Disc Removal

4. Apply an even coat of spline lubricant to hub (supplied with repair kit).

5. Install piston/friction disc.

6. Replace face seal and tighten to 50 in.lb. (5.7 N•m).

7. Lubricate new air chamber O-ring and O-ring contact surfaces with special O-ring lubricant (supplied with repair kit) and install.

8. Remove O-ring from piston/friction disc and clean O-ring contact surfaces (Figure 11).

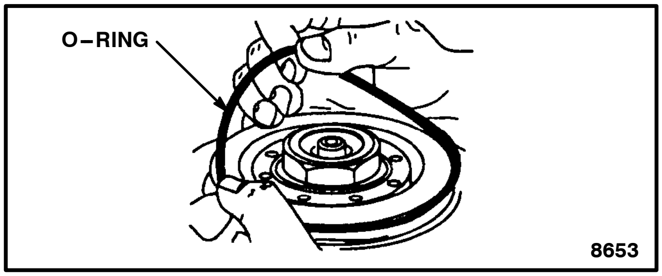


Figure 11. Large O-ring Removal

9. Lubricate new piston/friction disc O-ring and O-ring contact surfaces with special O-ring lubricant (supplied with repair kit) and install.

NOTE: Entire tube of O-ring lubricant should be used.

Air Cartridge Replacement

1. Remove air cartridge retaining ring from face seal (Figure 12).

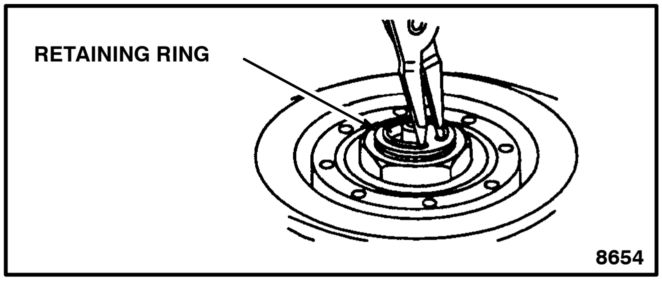


Figure 12. Retainer Ring Removal

2. Remove cartridge assembly, O-ring and end cup (Figure 13).

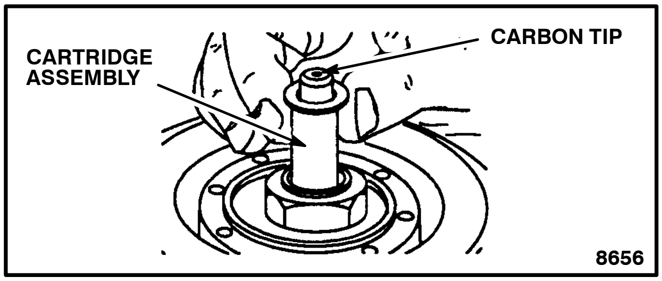


Figure 13. Cartridge Removal

3. Install new end cup (open end down), O-ring and cartridge assembly, and reinstall retaining ring (Figure 14).

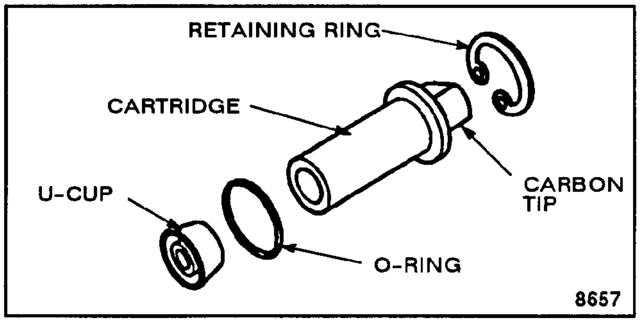

RETAINING RING
CARTRIDGE
U-CUP
CARBON TIP
O-RING
8657

Figure 14. Cartridge Assembly

NOTE: Retaining ring must be fully seated in groove.

4. Clean carbon tip of cartridge assembly and face seal with clean dry cloth.

NOTE: A clean carbon tip and face seal is important for extended clutch life.

Clutch Assembly

1. Install air chamber onto piston/friction disc

NOTE: All clutch components must be cleaned and free of all rust and foreign material prior to reassembly.

NOTE: Extreme care should be exercised when replacing the air chamber to avoid damage to O-rings.

2. Install and tighten socket head fasteners to 180 in-lbs (20.3 N·m).

3. Apply 90 to 120 p.s.i. of clean air to clutch to check for proper engagement, and verify that there are no air leaks.

Major Overhaul Dissassembly

1. Follow the procedure for “Clutch Fan Removal” and “Clutch Disassembly”.

2. Remove locknut retaining hub to journal (Figure 15).

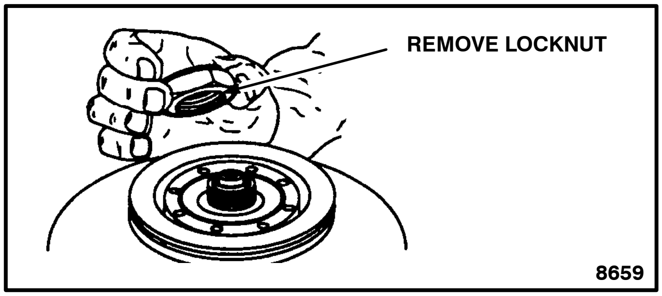

REMOVE LOCKNUT
8659

Figure 15. Locknut Removal

3. Remove spacer, seal and piston/friction disc assembly from splined hub.

4. Slide splined hub off journal bracket (Figure 16).

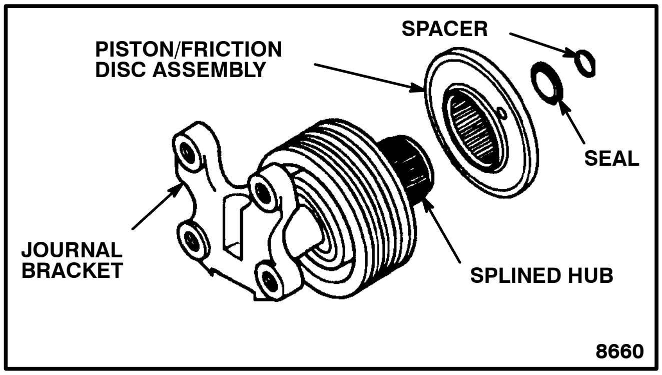

SPACER
PISTON/FRICTION DISC ASSEMBLY
SEAL
JOURNAL BRACKET
SPLINED HUB
8660

Figure 16. Hub Removal

Bearing Replacement

1. Remove journal spacer between hub and sheave (Figure 17).

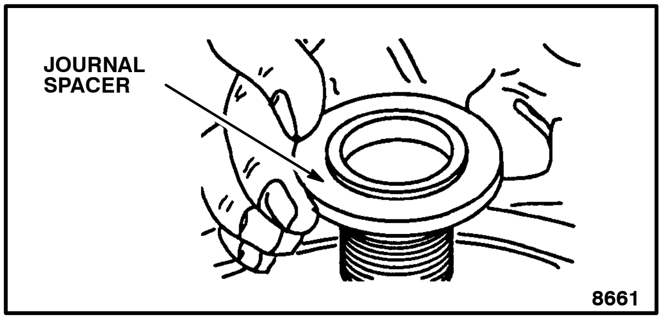

JOURNAL SPACER
8661

Figure 17. Journal Spacer Removal

2. Slide sheave off journal bracket spindle (Figure 18.)

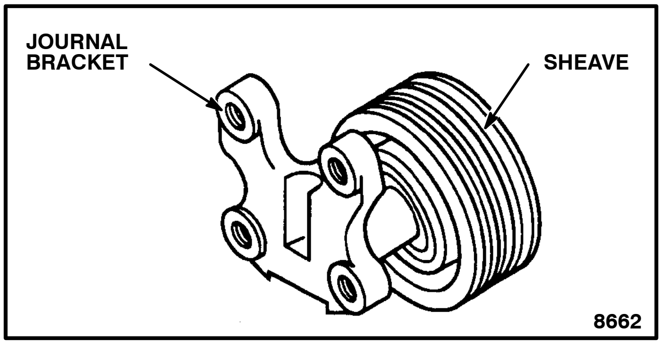

JOURNAL BRACKET
SHEAVE
8662

Figure 18. Sheave Removal

3. Support sleeve for bearing removal, and press both bearings out of sheave (Figure 19).

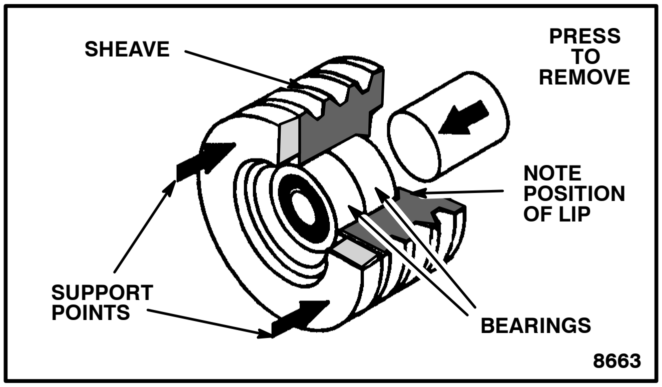

SHEAVE
PRESS TO REMOVE
NOTE POSITION OF LIP
SUPPORT POINTS
BEARINGS
8663

Figure 19. Bearing Removal

NOTE: Some clutch models contain spacers between bearings (Figure 20).

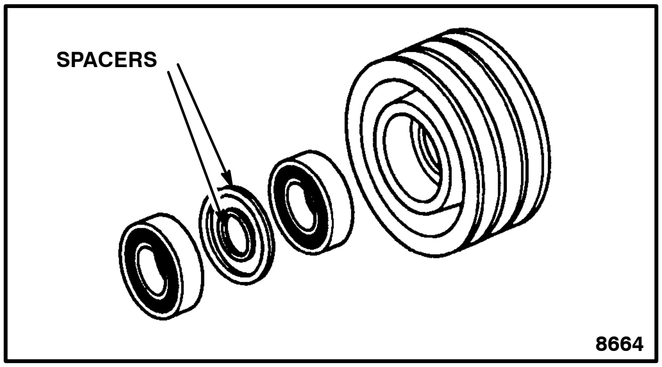

SPACERS
8664

Figure 20. Bearing Spacer Location

4. Position new bearings and press into place (Figure 21).

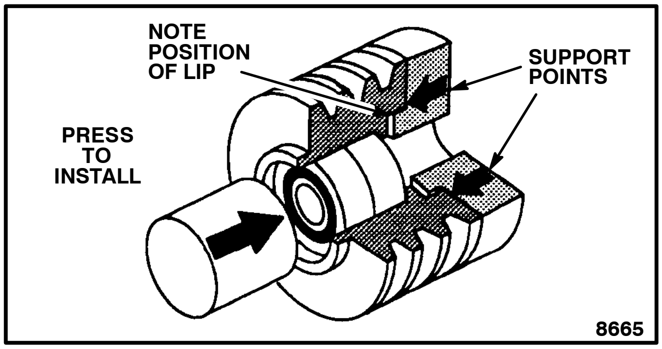

NOTE POSITION OF LIP
SUPPORT POINTS
PRESS TO INSTALL
8665

Figure 21. Bearing Installation

NOTE: All bearings are prelubricated and sealed, do not remove seals to lubricate.

Friction Facing Replacement

1. Inspect friction facing and replace if worn to 1/16 inch (1.6 mm) thickness, oily, or burnt.

2. Unfasten and remove button head capscrews, and remove friction facing (Figure 22).

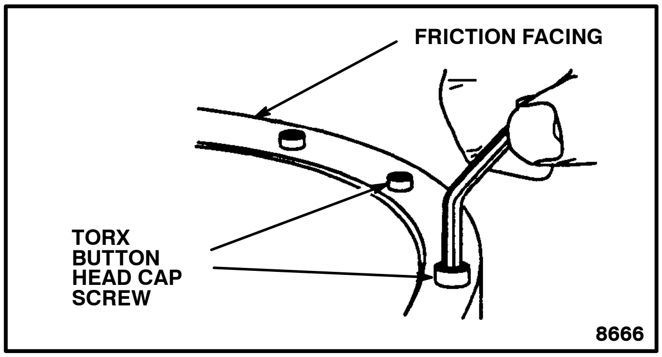

FRICTION FACING
TORX BUTTON HEAD CAP SCREW
8666

Figure 22. Friction Face Removal

3. Install new friction facing and tighten fasteners to 35-40 in-lbs (4.4-4.5 N·m)

4. If required proceed with procedures for “Air Cartridge Replacement” and/or “O-ring and Face Seal Replacement”.

Major Overhaul Assembly

1. Slide sleeve onto journal bracket spindle.
2. Install journal spacer.

NOTE: Install journal spacer with lip facing toward front of clutch.

3. Clean and Lubricate hub splines if “O-ring and Face Seal Replacement” procedure was not done.

4. Slide splined hub assembly onto journal bracket spindle.

5. Install seal and spacer onto journal bracket spindle.

6. Replace locknut and tighten to 150 ft-lbs (203 N·m).

7. Slide piston/friction disc assembly onto splined hub.

8. If “O-ring and Face Seal Replacement” was done, refer to procedure for “CLutch Assembly.”

9. Replace and tighten socket head fasteners to 180 in-lbs (20.3 N·m).

10. Reverse the procedure for “Clutch Fan Removal”, and install fan drive belts.

SHUTTER ASSEMBLY

The air-actuated shutter assemblies require very little maintenance. However, in addition to the normal lubrication provided by the filter, it’s recommended that the shutter air cylinder’s piston and seals be lubricated with a silicon base lubricant every 50,000 miles (80,450 km). This is accomplished by disconnecting the air tubing and spraying a small amount of lubricant into cylinder inlet port. Work shutters through a few cycles with clean dry air and reconnect control system air.

If shutter should ever need repair, follow the procedure for removing shutter assembly from radiator assembly later in this sub-section. The following procedure should be followed for replacement of blades, control rods or air cylinders.

1. With shutter’s exhaust side flat on table, remove lower cylinder attaching bolt.

2. Remove cylinder rod end E-clip retainer and slide cylinder off actuator rod.

3. Unfasten and remove shutter return springs.

4. Unfasten and remove frame retaining bolts at each corner.

5. Remove E-clips retaining blades and/or control rod and replace damaged parts

NOTE: Make note of locations where E-clips are placed for reassembly.

6. Reverse procedure, and install onto radiator assembly per procedure.

AIR CONTROLS

Most of the air control system components (Figure 23, 24, and 25) require little maintenance, and some components are so designed as to be unrepairable. Items such as plastic tubing, fittings, shutterstats and air diverting switches should be considered throw-away items once they are found to be unfit for service. Two Components that do demand some periodic service and/or maintenance are the Bendix TR-3 inversion valves and the Kysor shutterstat filter.

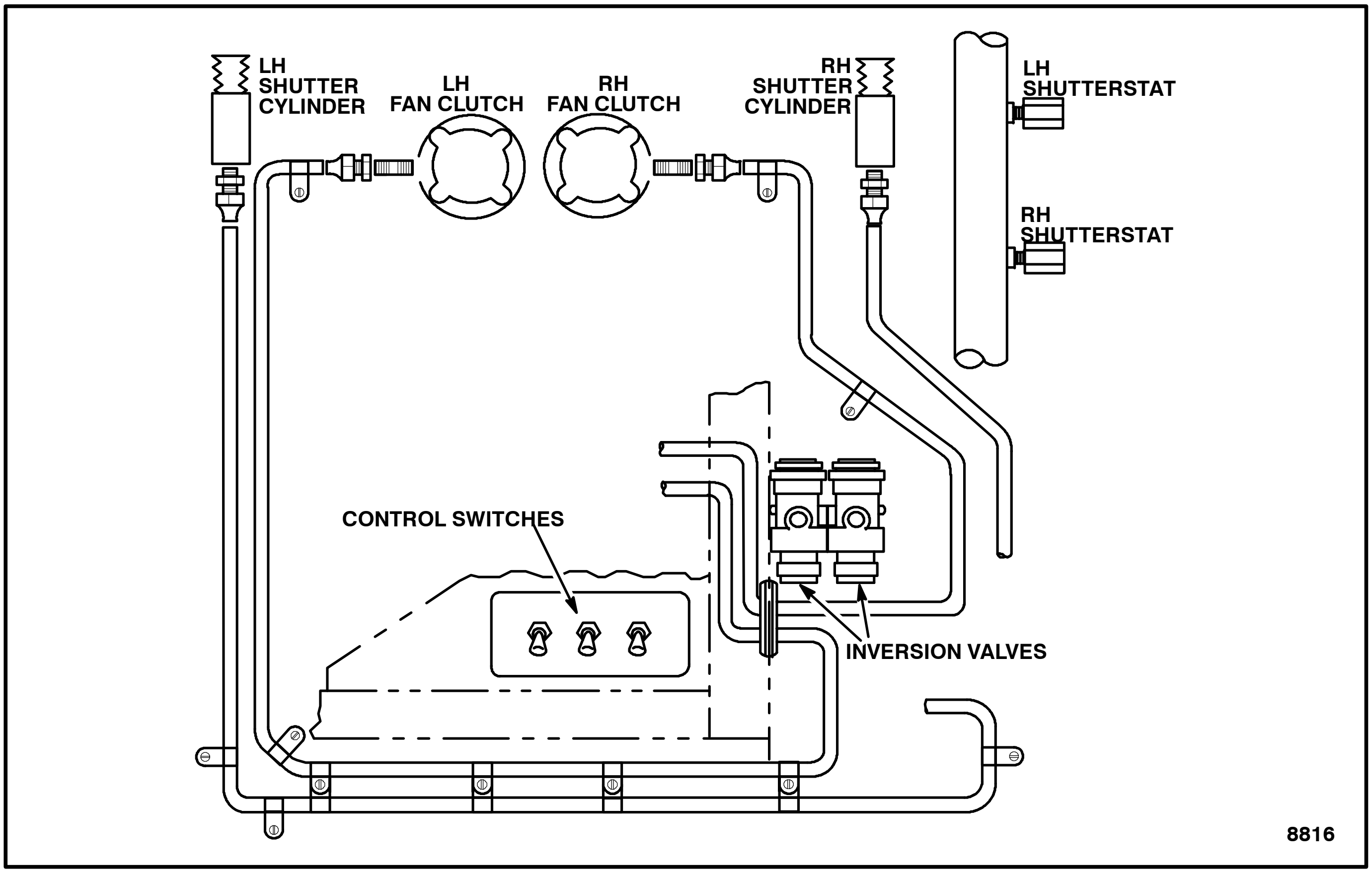


Figure 23. Control System Components

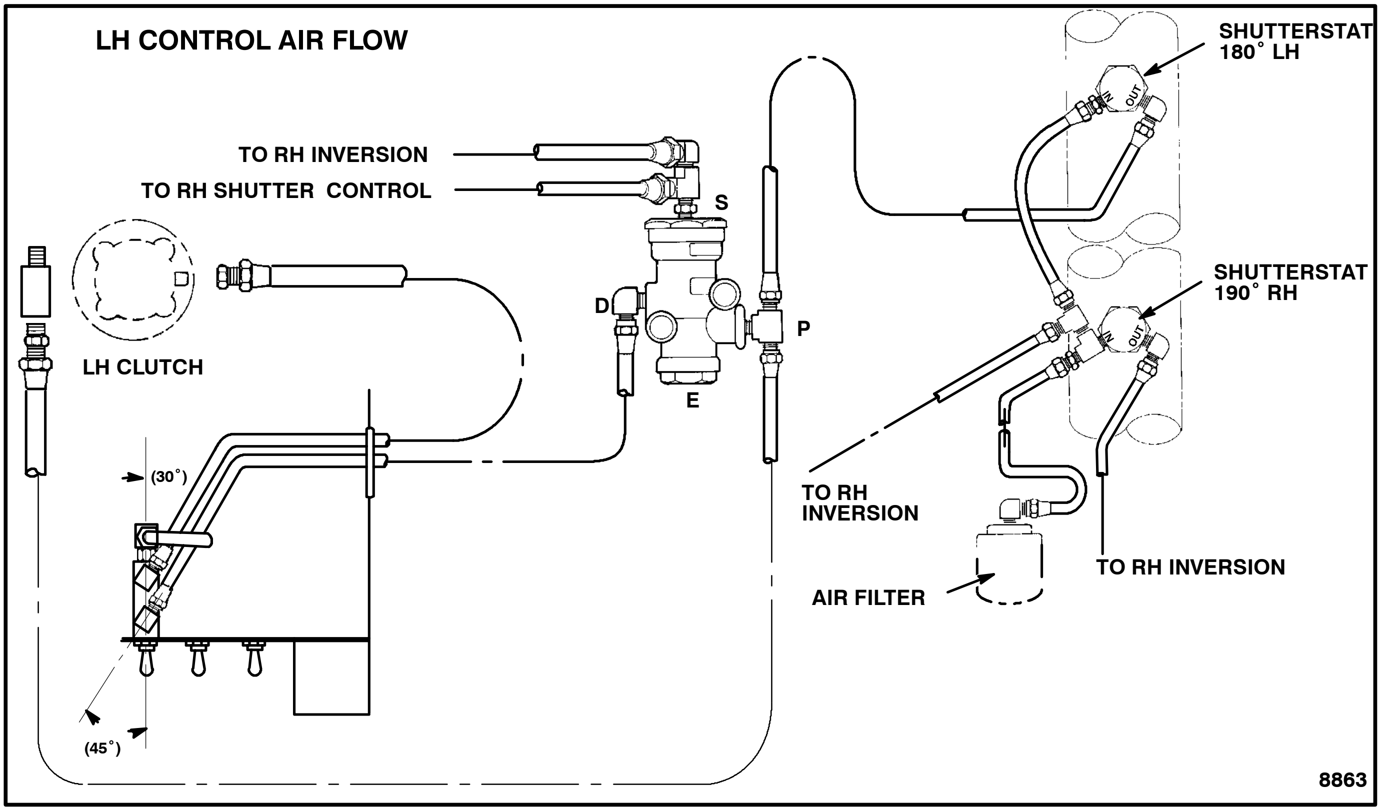

LH CONTROL AIR FLOW
TO RH INVERSION
TO RH SHUTTER CONTROL
S
D
P
E
LH CLUTCH
(30°)
(45°)
SHUTTERSTAT 180° LH
SHUTTERSTAT 190° RH
IN
OUT
TO RH INVERSION
AIR FILTER
TO RH INVERSION
8863

Figure 24. Left Hand Air Flow

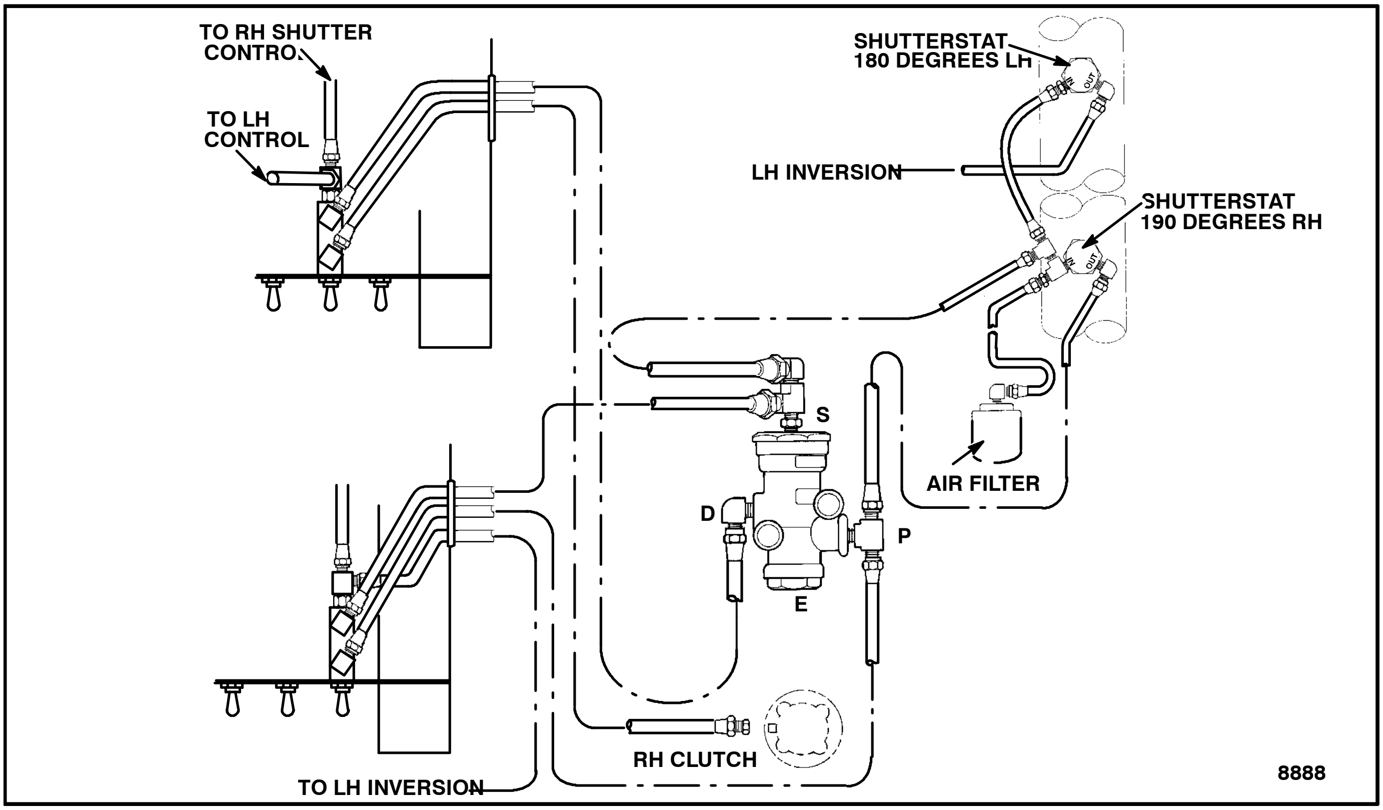

TO RH SHUTTER CONTROL
TO LH CONTROL
SHUTTERSTAT 180 DEGREES LH
LH INVERSION
SHUTTERSTAT 190 DEGREES RH
IN
OUT
S
AIR FILTER
D
P
E
RH CLUTCH
TO LH INVERSION
8888

Figure 25. Right Hand Air Flow

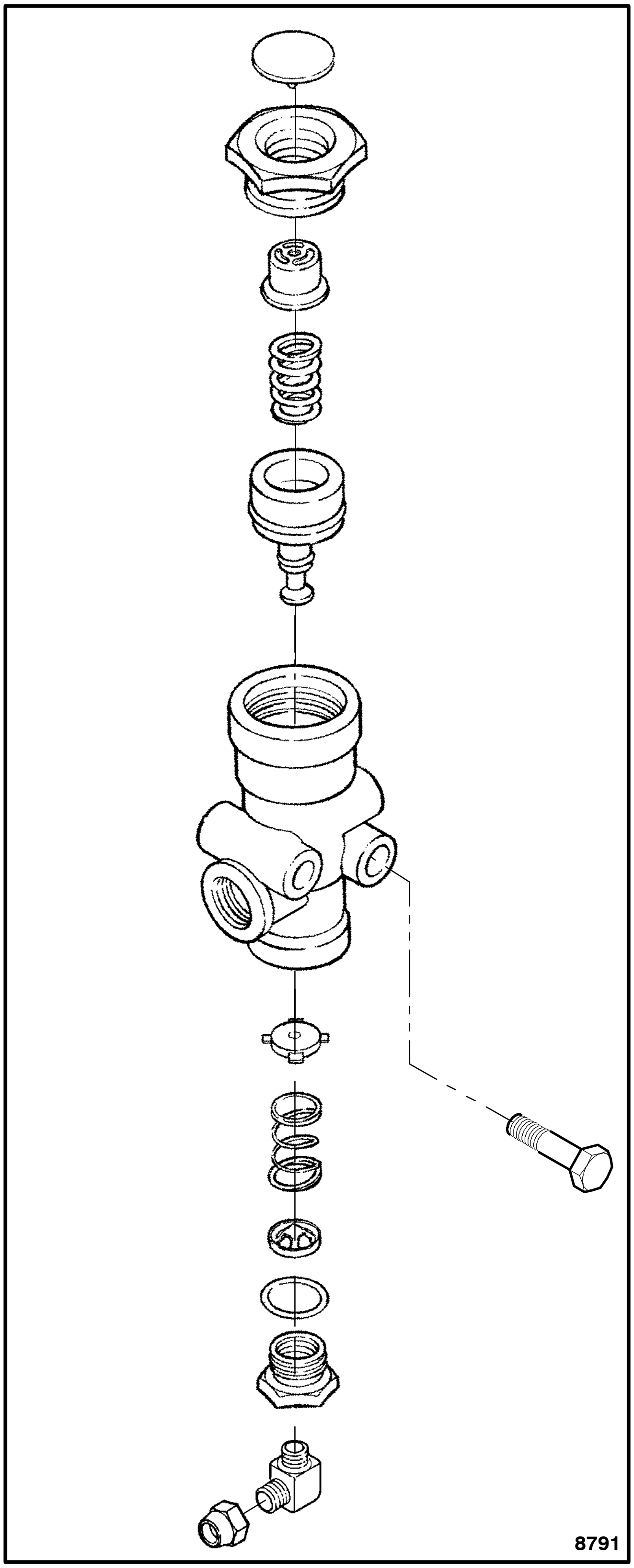


Figure 26. Inversion Valve

Every 100,000 miles (160,900 km) or each 3600 operating hours the inversion valve (Figure 26) should be disassembled, cleaned and inspected. The exhaust seat and inlet seat should be checked for nicks or burrs. Inspect all rubber parts for signs of cuts, abrasion, swelling or deterioration, and replace if necessary. Follow the disassembly/assembly procedures in order.

The air filter fluid chamber holds approximately one ounce (28 ml) of fluid. Part of the weekly maintenance procedure should be to drain the filter by opening the draincock at the bottom of the filter body while the filter is under pressure. During cold weather operation, the filter should be drained daily.

At intervals of 3,000 miles (4,800 km), one ounce (28 ml) of Kysor Air Filter Fluid (PN 6-10-33) should be added to the filter. Remove the plug on the top of the filter body, add fluid and replace the plug. At intervals of 10,000 miles (16,000 km) the air filter should be disassembled and the felts cleaned with commercial solvent or replaced (Figure 27). When reassembling the filter use new gaskets.

Shutterstat Replacement

Before the shutterstat can be removed and replaced, it will be necessary to drain the engine coolant to a level below the stat to be removed. Refer to “Draining Cooling System” later in the section for procedures.

1. Disconnect the shutterstat air lines, plug and tape mark them to prevent contamination and to correctly locate at assembly.
2. Unscrew and remove the shutterstat.

NOTE: The shutterstat is non-serviceable and should be discarded.

3. Install new shutterstat, and reconnect the air lines.
4. Refill the cooling system, and check shutterstat’s function at engine operating temperature.

Air-Diverting Switch Replacement

1. Disconnect the switch air lines, plug and tape mark them to prevent contamination and to correctly locate at assembly.
2. Unfasten and remove hex nut and lockwasher that mount switch to plate.

NOTE: The switch is non-serviceable and should be discarded.

3. Install new switch, and reconnect the air lines.
4. Check clutch and shutter function at engine temperature.

Inversion Valve Disassembly

1. Disconnect and mark for installation all air lines.
2. Unfasten mount bolts and remove valve from radiator assembly.

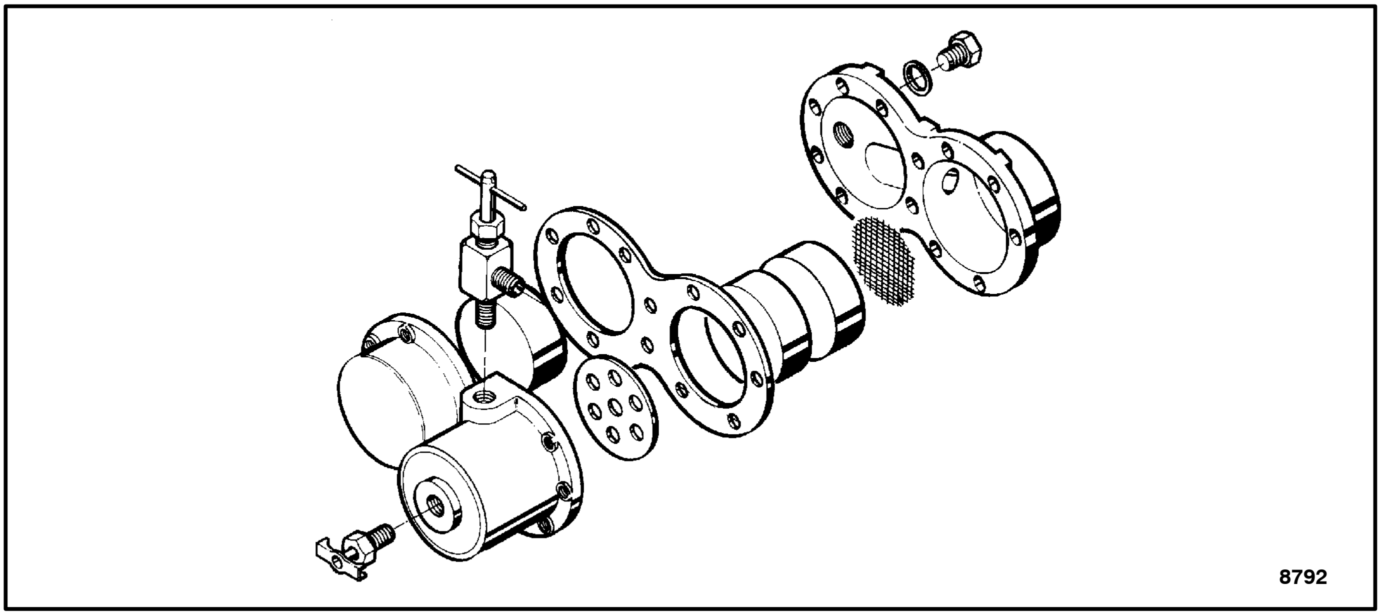


Figure 27. Shutterstat Air Filter

3. Remove exhaust port cap nut and O-ring.
4. Remove diaphragm retainer and piston spring.
5. Remove any shims or washers if present.
6. Remove piston from body.
7. Remove piston O-ring and exhaust stem O-ring.
8. Remove supply cap nut and O-ring.
9. Remove valve stop and spring.
10. Remove inlet and exhaust valve.

NOTE: Care should be taken if clamping valve in vise. Excessive force can cause distortion of valve body.

Cleaning and Inspection

Wash all metal parts in a good cleaning solvent.

Wipe all rubber parts clean.

Inspect all parts for signs of wear or deterioration.

Check springs for cracks, corrosion, or distortion.

Inspect piston and its exhaust seat, body bores, and inlet valve for nicks, scratches, or burrs.

Replace all parts not considered serviceable during inspection.

Inversion Valve Assembly

1. Install inlet and exhaust valve in body (supply port).
2. Install inlet valve spring and valve stop (center stop on spring).
3. Install O-ring on supply cap nut and install and tighten cap nut to 100 in-lbs (11.4 N·m)
4. Install piston and exhaust stem O-ring on piston.

NOTE: Before assembling the valve, lubricate the piston O-rings and body bores with Bendix silicone lubricant P/N 291126 or equal.

5. Install piston into body.
6. Install shims or washers if used.
7. Install piston spring.
8. Install diaphragm retainer and exhaust diaphragm.
9. Install O-ring on exhaust cap nut and install and tighten nut to 275 in-lbs (31.4 N·m).
10. Test the rebuilt valve per the “Operating and Leakage Test” that follows.

Operating and Leakage Test

NOTE: The following checks should be made with two test gauges known to be accurate.

Install one test gauge in a common control and supply line; install the other gauge in the delivery port. Gradually apply pressure to the common supply and control (pilot) lines. On ascending pressure, note at what pressure exhaust occurs and compare with stated pressure. With supply and control ports pressurized, apply a soap solution around the supply port cap nut. No leakage is permitted. Apply soap solution to the delivery and exhaust ports, a slight bubble leakage is permissible. Excessive leakage would indicate a faulty O-ring or inlet valve. Slowly decrease pressure in the control cavity and note at what pressure delivery is made and compare to stated pressure.

RADIATOR ASSEMBLY

It is essential that the radiator cores be kept free from corrosion and debris, and that regular maintenance be performed in conjunction with the other components of the cooling system. See sub-section on "Coolant" later in the section for further details.

As there are no moving parts on the radiator assembly, no set interval for service, aside from that specified for coolant is necessary. However, inspection of the header joint seal, air seals, and fasteners of attaching components should be made at the coolant inspection or test intervals.

RADIATOR MODULE REMOVAL

1. Turn battery switch to "Off" position.
2. Drain cooling system. See "DRAINING COOLING SYSTEM".
3. Disconnect radiator door stop lamp wiring.
4. Place lift to support and remove door.
5. Remove trim molding above radiator door.
6. Remove trim panel across top of radiator door opening.
7. Disconnect prop rods from frame and tyrap to door.
8. Remove the cooling compartment door hinge bolts.
9. Remove cooling compartment door.
10. Remove engine compartment doors.

NOTE: Two people are required to remove doors.

A. Disconnect license plate wiring.
B. Disconnect door prop rods.
C. Remove door hinge mounting bolts.
D. Repeat B and C for the right-hand door.

NOTE: Two people are required (one to hold end of trim to prevent breaking it). DO NOT lose trim end caps or spacers.

11. Unfasten and remove the curbside louver panel. Remove two screws (2) at rear and side (Figure 28).

NOTE: Two people may be necessary to slide out panel while undoing the screws. DO NOT lose the rubber washers.

12. Disconnect and remove outlet radiator tube.

A. Loosen hose clamp at radiator and at joint by the door frame.

B. Loosen mounting clamp on door frame and pull tube down and out of panel .

NOTE: Insert plug to prevent remaining coolant in the radiator from pouring out.

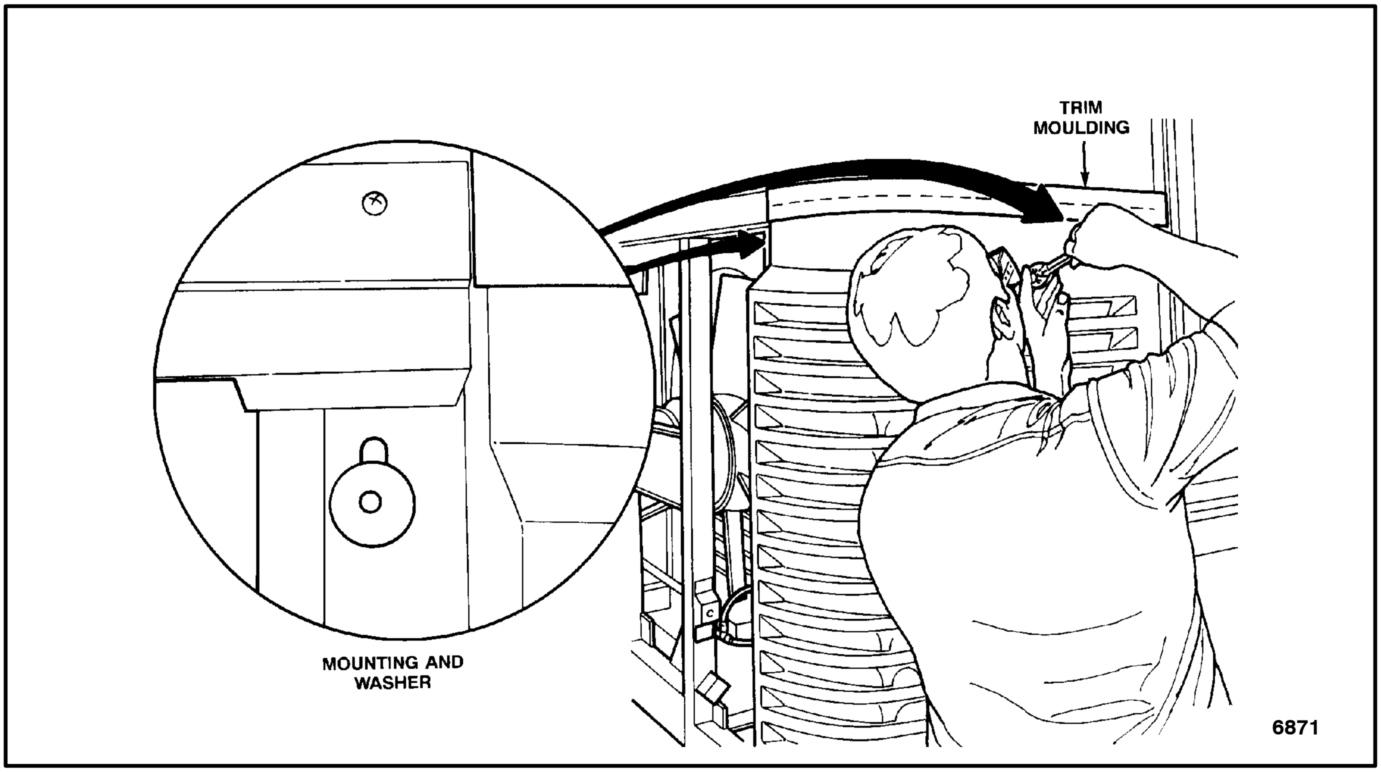


Figure 28. Louvered Panel Removal

13. Loosen the air line on top of the shutterstat air filter and let the pressure bleed off. Disconnect and remove airline from filter to shutterstat.

⚠ WARNING ⚠

Wear proper eye protection. Be careful that air pressure does not blow debris into eyes when disconnecting the air supply line.

14. Disconnect and remove the inlet radiator tube.

A. Disconnect bracket holding radiator inlet tube.

B. Loosen clamp at top of inlet radiator tube, pull free, twist tube 180 degrees to right, pull up, swing top down, to right and remove (Figure 29).

15. Loosen engine-to-fan drive belt idler, and stow belt out of way in the module.

16. Remove radiator tube from across top of engine at each thermostat and at the upper right corner of the engine compartment.

17. Cover engine thermostat openings to prevent debris from falling in and getting in the cooling system.

18. Remove aerator line from top left corner of radiator. Place line up out of the way.

19. Remove bolts (12) holding radiator module in coach .

20. Measure distance between vertical frame members and cut a spreader board approximately 1/2 inch longer. Set the board flat against the top left engine door mounting bolt and drive board up until approximately horizontal with opening. This will spread the frame enough to allow easier removal of the radiator module (Figure 30).

NOTE: The surge tank line may have to be loosened to insert the spreader.

21. Place lift in position and raise enough to place pressure against bottom of module frame (Figure 31).

⚠ CAUTION ⚠

Be careful that the lift does not damage ether cup assembly on filter housing or other engine parts.

22. Clamp or fasten the radiator module to the lift (Figure 32).

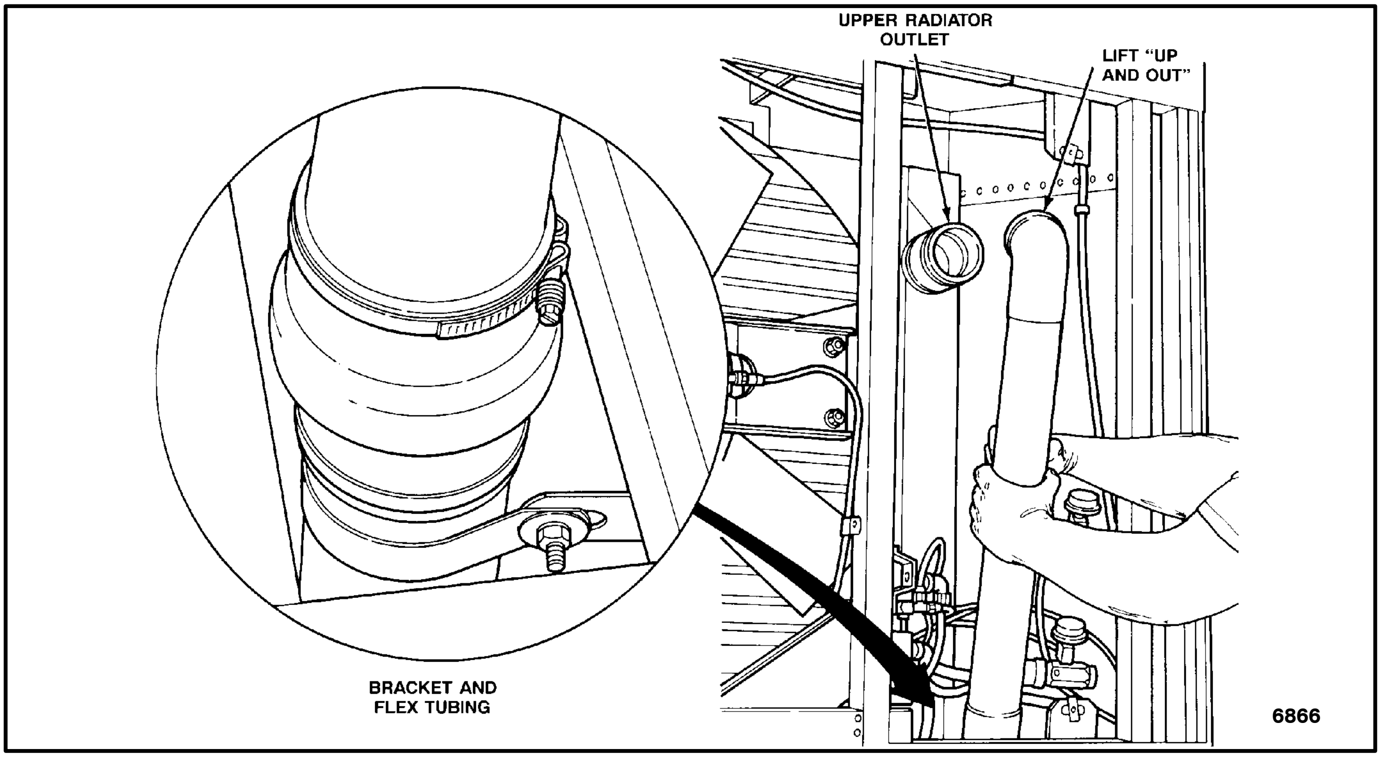


Figure 29. Inlet Tube Removal

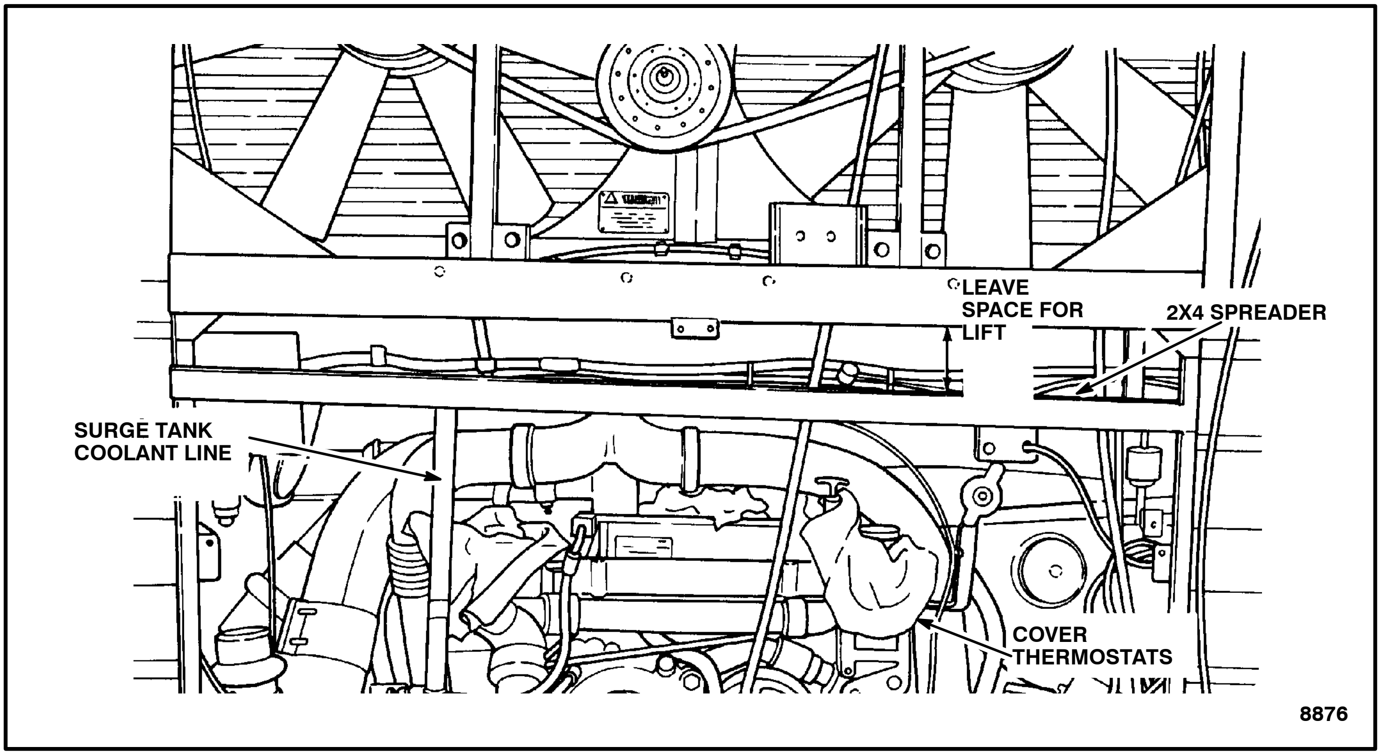

LEAVE SPACE FOR LIFT
2X4 SPREADER
SURGE TANK COOLANT LINE
COVER THERMOSTATS
8876

Figure 30. Spreader Placement

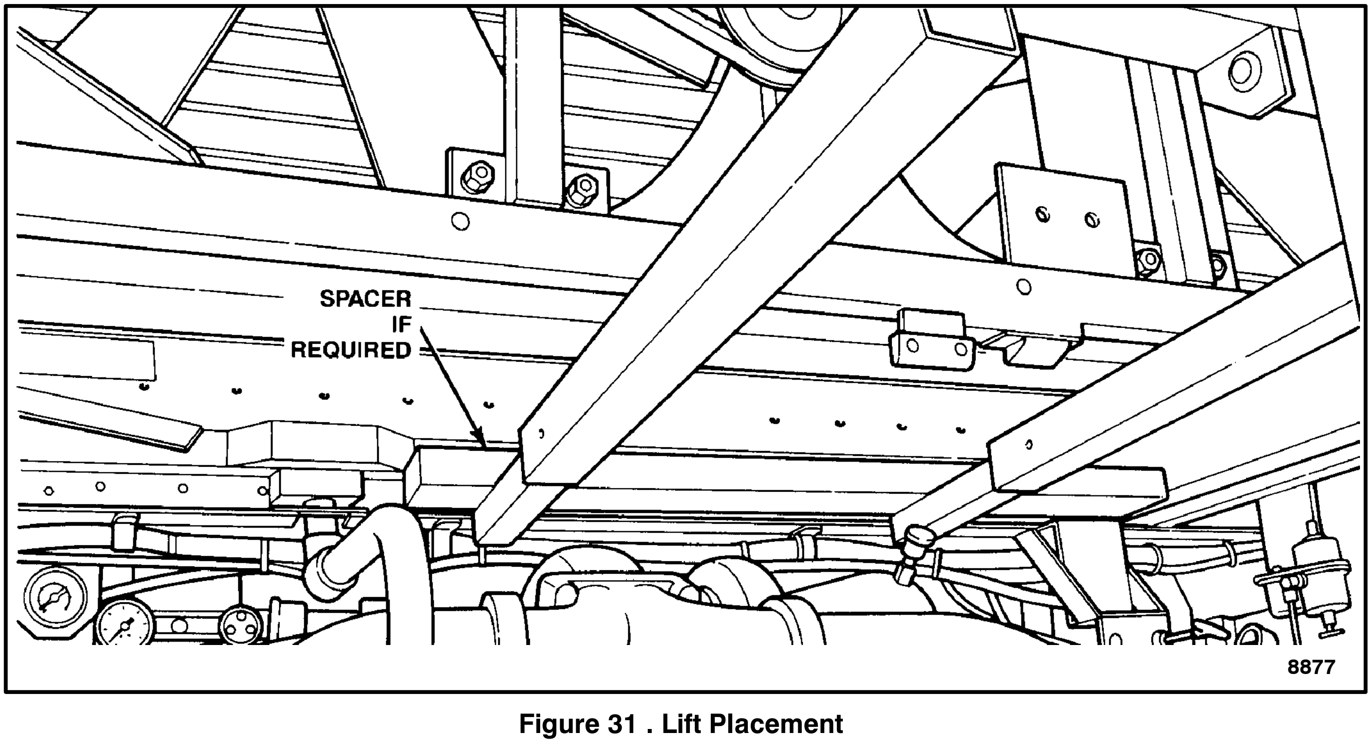

SPACER IF REQUIRED
8877

Figure 31 . Lift Placement

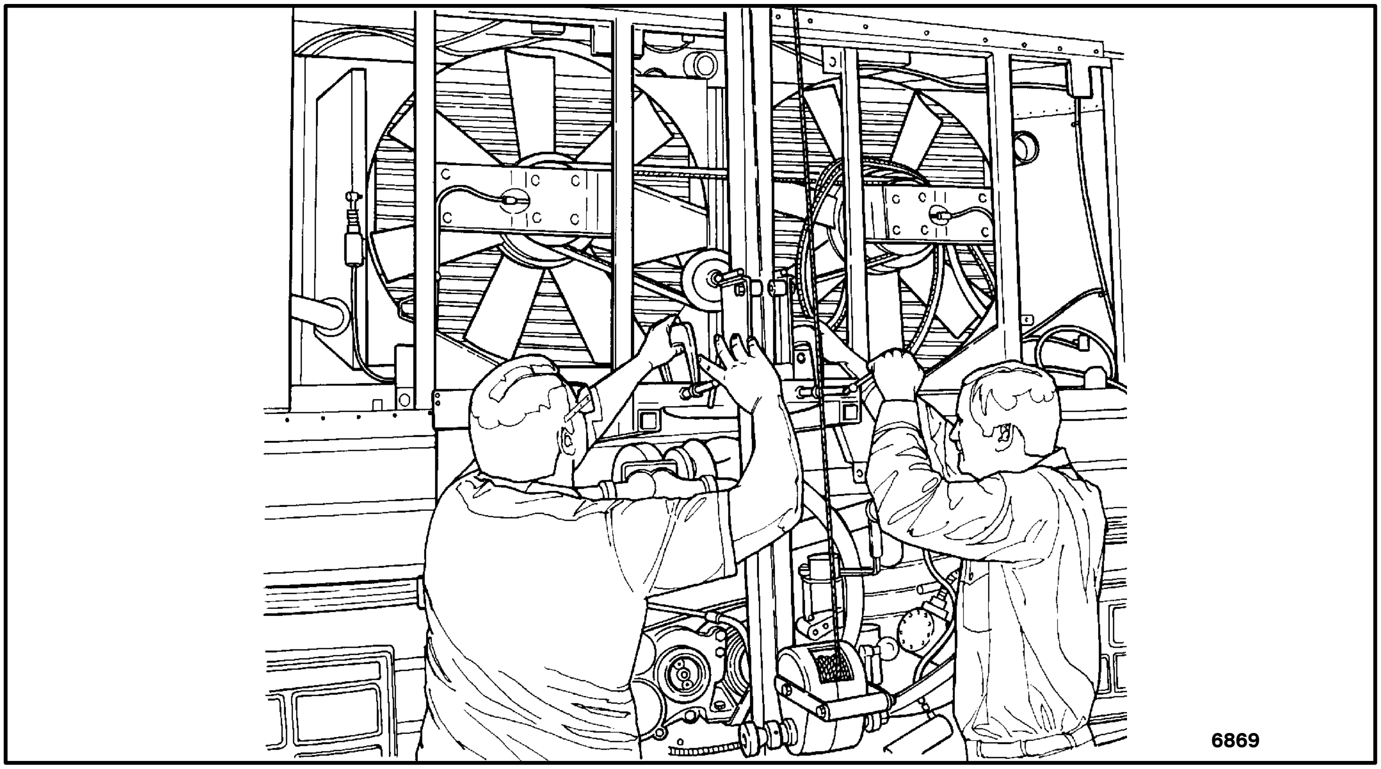


Figure 32. Clamp Module to Lift

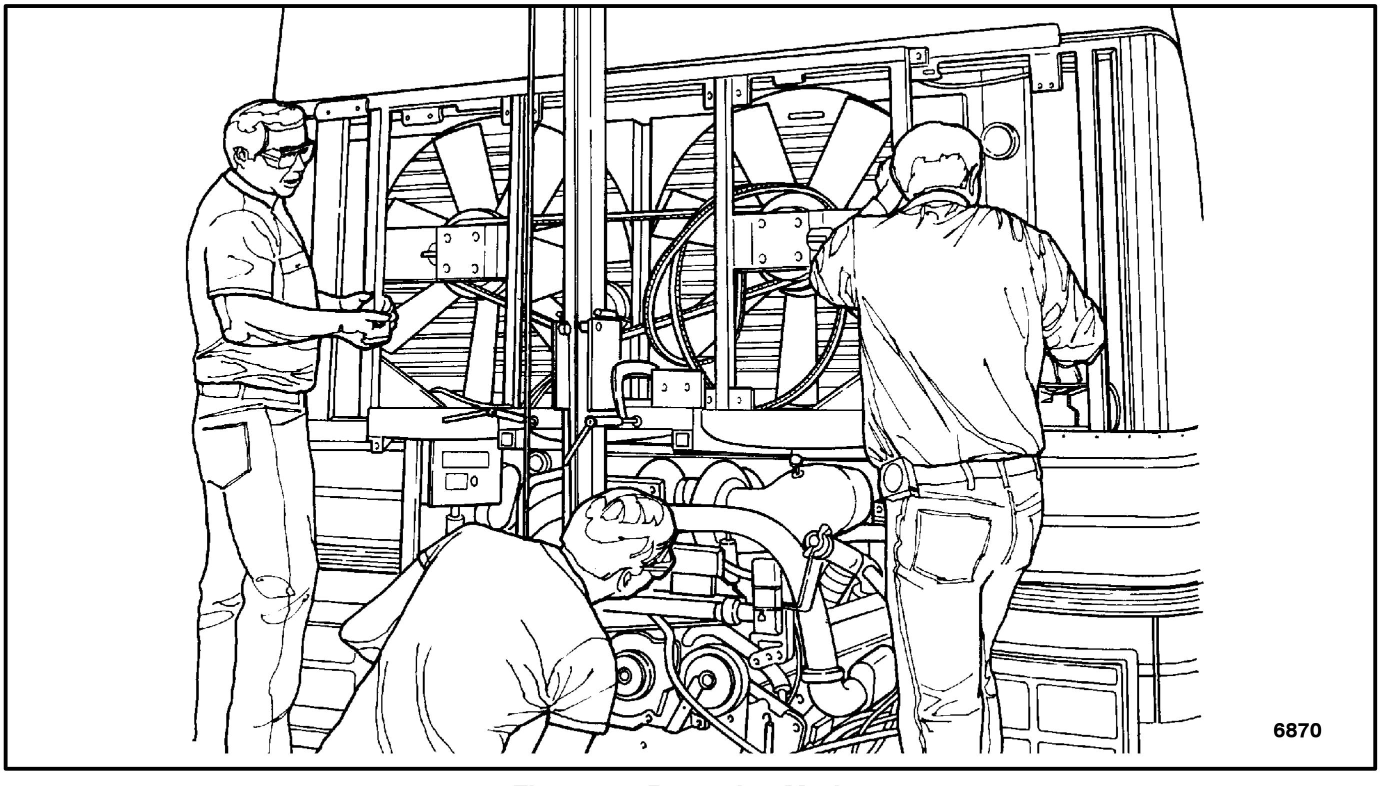


Figure 33. Removing Module

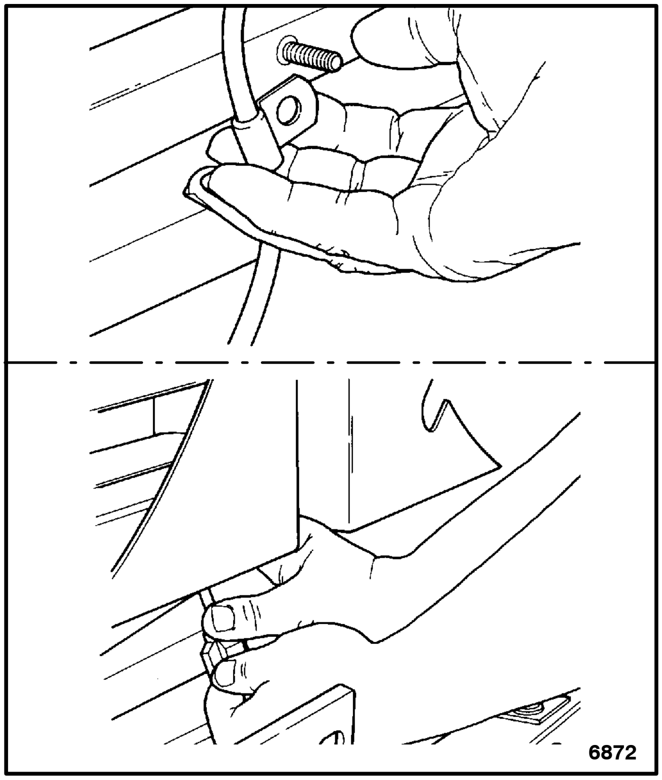


Figure 34. Clamp and Air Line Removal

NOTE: Three people are required to pull the module out of the radiator compartment (Figure 33), two people to work the module loose and the third to operate the lift).

NOTE: Pry bars may be necessary. Use heel bar driven between the mounting brackets to loosen the module.

⚠ CAUTION ⚠

If spacers have been placed between the module frame and the coach frame for spacing at the lower mounting brackets, remove them before pulling the module out. Mark locations of spacers and save for re-use.

⚠ CAUTION ⚠

DO NOT drag the module's bottom while removing from coach.

23. Remove drain plug from radiator and drain remaining coolant.

RADIATOR MODULE DISASSEMBLY

1. Remove air line clamps (Figure 34).
2. Disconnect primary and secondary fan clutch and shutter cylinder air lines.
3. Disconnect and remove fan-to-fan idler pulley .
4. Disconnect and remove primary and secondary fan clutch assemblies and their mount brackets (Figure 35).

NOTE: Procedures #1 thru #4 may be completed during "Radiator Module Removal".

5. Check both seals on front of radiator and remove if damaged or hard.
6. Remove radiator mounting bolts.

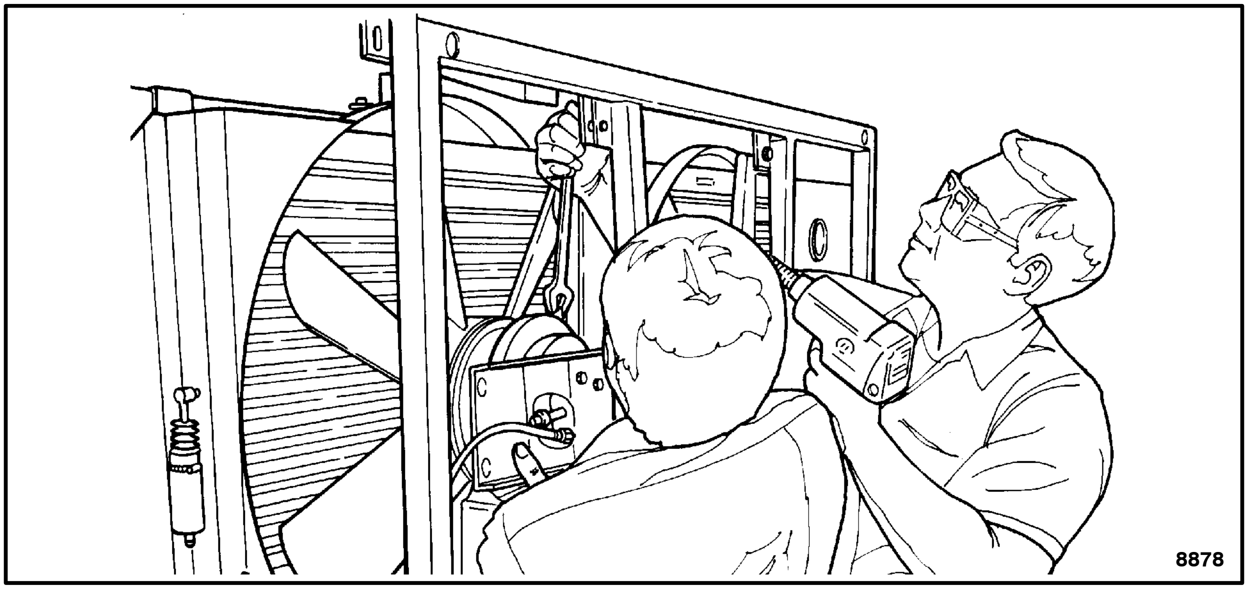


Figure 35. Fan, Clutch and Bracket Removal

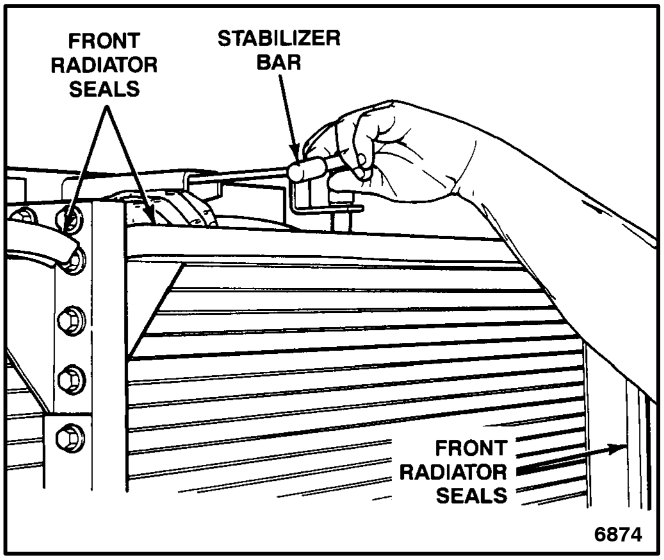


Figure 36 Stabilizer Bar Removal

7. Remove stabilizer bars (Figure 36.).

NOTE: Two people are required to steady radiator when stabilizer bars are removed.

8. Remove the radiator assembly from the module (Figure 37) and lay on bench, shroud/shutter assemblies up.

RADIATOR DISASSEMBLY

1. Unfasten and remove radiator shrouds from shutter assemblies.

2. Unfasten and remove radiator shutter assemblies from radiator assembly.

NOTE: A pry bar may be needed to loosen the sealant between the shutters and the radiator.

3. Remove aerator line fitting if installing a new radiator assembly and reinstall on new radiator assembly.

4. If new core, tank and header assembly is to be installed, unbolt radiators at header and break apart.

RADIATOR ASSEMBLY

1. If new core, tank and header is to be attached, lay radiator on bench with the inlet/outlet ports down.

2. Install header gasket to cleaned surface of mating radiator with appropriate sealant, install bolting and tighten.

3. Check exterior radiator seals for damage or deterioration, replace as necessary. Install new seals, if new radiator assembly.

4. Replace drain plug if removed.

5. If new radiator, reinstall aerator fitting.

6. Replace as necessary the shroud/shutter-to-radiator seals if damaged or deteriorated.

7. Place shutter assemblies on radiator and align the top outer corners tight against the radiator corner brackets.

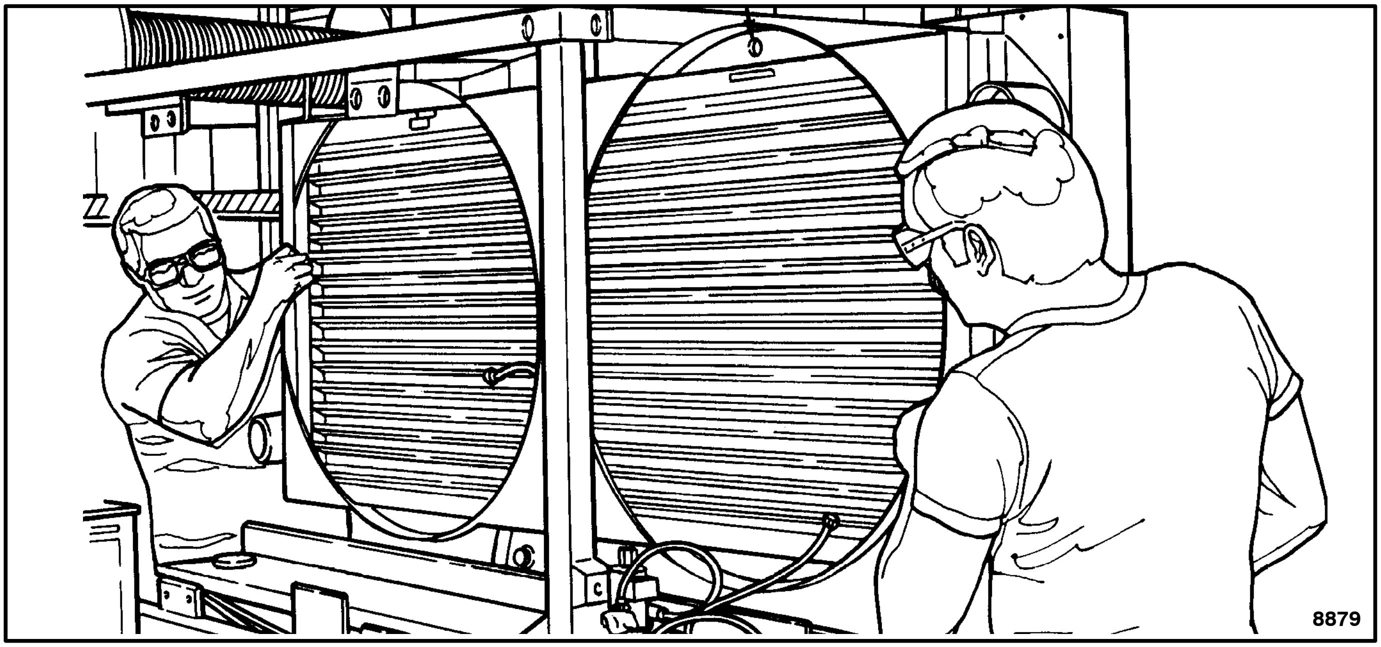


Figure 37. Radiator Assembly Removal

NOTE: Be sure the top outside corners are tight against, but, not on top of the radiator corner bracket (Figure 38). the top and bottom center mounting screw holes do not have an access hole in the shroud for a screwdriver, drill a screwdriver hole before placing on the radiator.

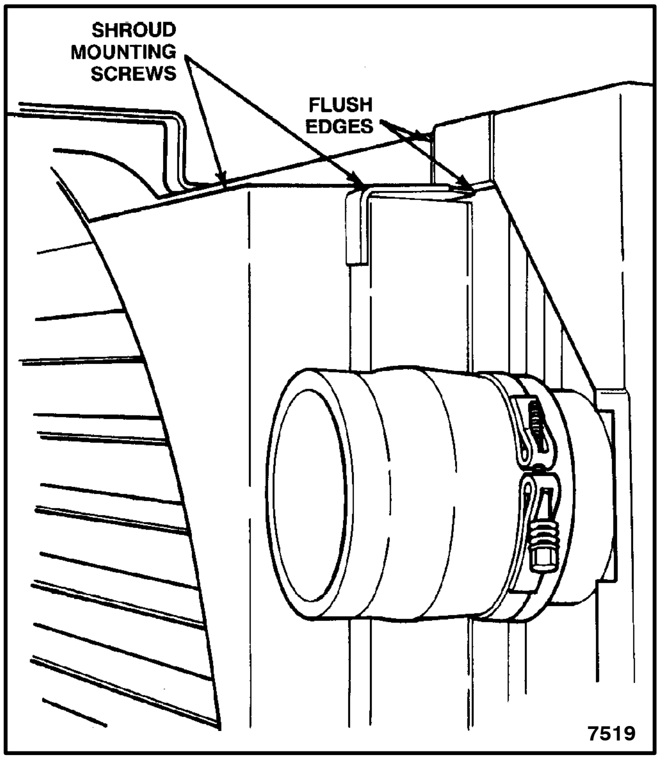


Figure 38. Shutter-To-Radiator Alignment

8. Center punch each mounting hole, if reinstalling on new radiator.

9. Drill mounting holes with a #25 bit, if reinstalling on new radiator.

⚠ CAUTION ⚠

Lay a large flat metal plate on the radiator core (under each hole) to prevent drilling fragments from falling into the core and the bit from hitting the core, if reinstalling on new radiator.

10. With a self-tapping mounting screw and power driver, prethread each hole, drill and tap lubricant will ease pretapping and smoother threads, if reinstalling on new radiator. Use metal shield to prevent hitting core.

11. Locate shutter assemblies on old radiator and reattach.

12. Mount shrouds onto shutter assemblies and reattach.

RADIATOR MODULE ASSEMBLY

1. Set radiator in module frame.

2. Check alignment of the front lower seal contact angle on frame (Figure 39) and straighten if out of adjustment.

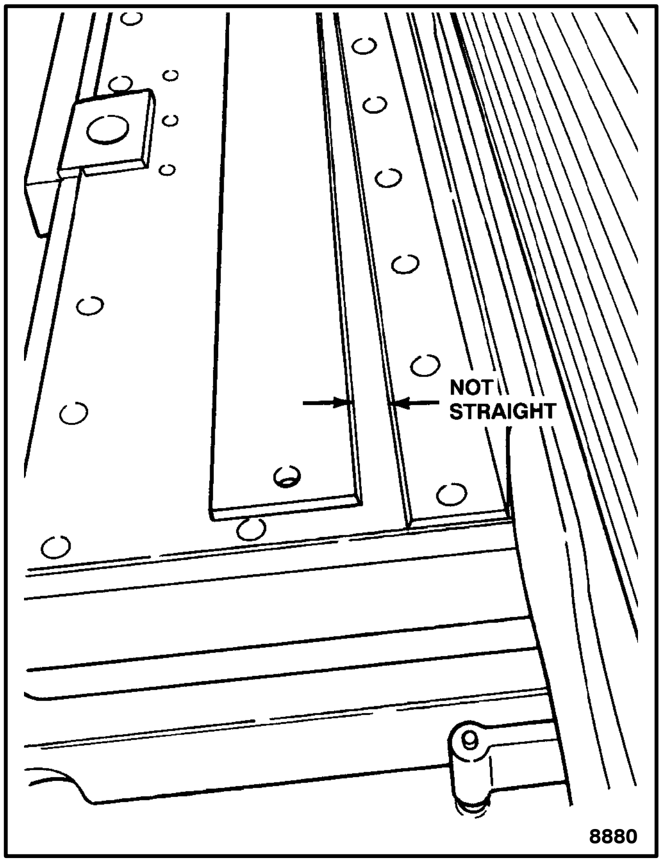


Figure 39. Front Seal Angle Alignment

3. Install one stabilizer bar (loosely).

⚠ CAUTION ⚠

Be sure the bolts into the radiator are not too long. The stabilizer bar goes under the bottom of the bracket on the module frame.

4. Raise the module to align radiator assembly.

5. Align bottom radiator mounts and install fasteners.

⚠ CAUTION ⚠

Do not overtighten the radiator mounting bolts.

6. Install fan clutch and shutter cylinder air tube mounting clips.

7. Measure top and bottom radiator-to-frame distances both sides and plumb radiator's vertical

(Figure 40) Install second stabilizer bar, and tightening both.

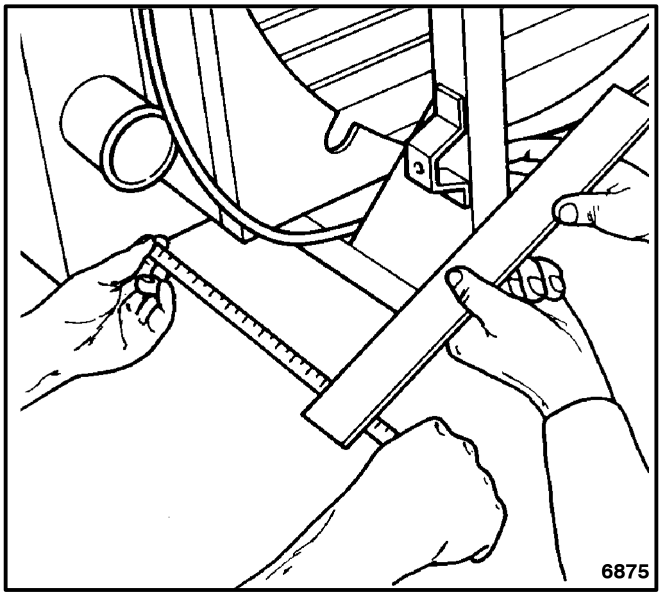


Figure 40. Radiator Plumb to Frame

NOTE: Be sure that rubber cushion is inserted between the stabilizer bar and the radiator.

RADIATOR MODULE INSTALLATION

1. Check Radiator sealing panels in cooling compartment for proper sealing contact. Pull panel outward if contact is not being made.

2. Clamp the radiator module to the lift. Align the module with the coach cooling compartment and slide into position.

⚠ CAUTION ⚠

Be careful that the lift does not damage the Ether cup or other engine parts. Make sure the body skin by the lower mounting brackets is not damaged while installing the module.

3. Place C-clamps on the coach/module mounting brackets to draw the module into the coach.

4. Remove the lift.

5. Remove the spreader board.

6. Install the module mounting bolts (12).

7. Connect the aerator line at the top left corner of the radiator.

8. Install the radiator tube across the top of the engine.

NOTE: Check the tube openings for damage. Straighten if necessary.

9. Reconnect the surge tank make-up water tube if loosened.

10. Install and connect the inlet and outlet radiator tubes to the radiator and engine compartment piping.

A. Connect the outlet tube's lower mounting bracket.
B. Connect the inlet tube's mount bracket.
C. Tighten the inlet/outlet constant torque clamps.

NOTE: For proper operation of the controls, the radiator tube must be in a vertical position.

11. Install primary and secondary fan clutch assemblies onto their mounting brackets.

12. Attach the mount brackets complete with fan clutch assemblies, and center in their shrouds.

NOTE: Install both fan belts before mounting the primary fan clutch and bracket to module.

13. Reconnect fan clutch and shutter cylinder air lines.

14. Install fan-to-fan drive belt tension device and idler pulley.

15. Install engine-to-fan drive belt tension device and idler pulley.

NOTE: Check the fan blade to shroud clearances by rotating fan blade.

16. Set the fan-to-fan and engine-to-fan belt tension per specifications using tensioner tools (Figure 41).

17. Connect air tubes of the control system

18. Connect the supply air line from filter.

19. Install the louvered panels over the cooling compartment openings.

20. Install the trim panel across radiator door opening.

21. Install trim molding above radiator door.

22. Install radiator door, and attach hinges and air springs.

23. Install engine compartment doors.

24. Fill cooling system (See appropriate filling procedure).

25. Start engine and check for leaks and proper operation.

SERVICE TOOLS

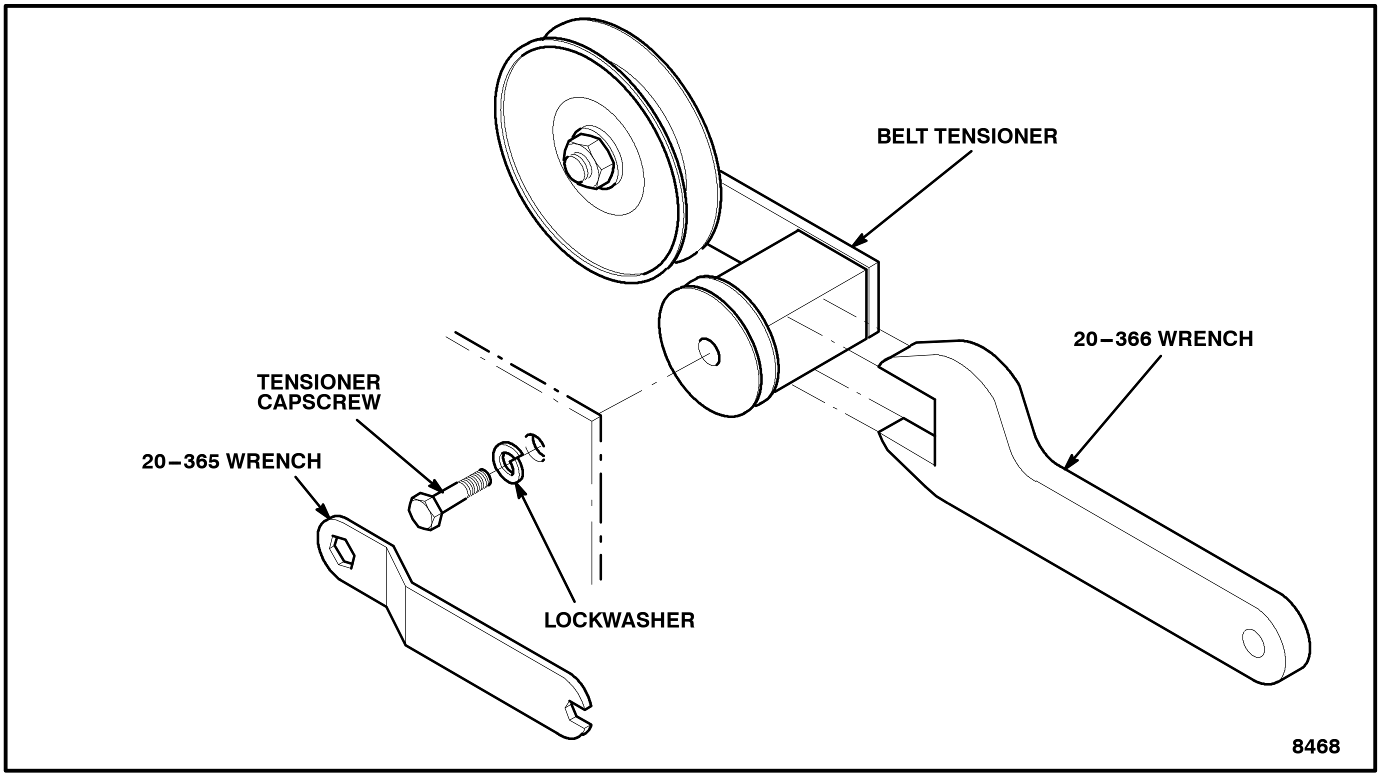


Figure 41. Belt Tensioner Service Tools

SPECIFICATIONS

RADIATOR ASSEMBLY	
Capacity (System)	32.5 U.S. Gals. (123 liters)
Manufacturer	Young Radiator Co.
Design	Cross-Flow Finned-Tube
Location	(Vertical Mount) Rear of Coach
CLUTCH ASSEMBLY (RADIAL FAN)	
Manufacturer	Horton
Design	(Air Actuated) Friction Disc
Part Number	6L-6-261
SHUTTERSTATS	
Manufacturer	Kysor
Part Number (180°F)	6L-10-75
Temperature Range	177-185°F (80-85°C)
Part Number (190°F)	6L-10-76
Temperature Range	187-195°F (86-90°C)
SHUTTERSTAT FILTER ASSEMBLY	
Manufacturer	Kysor
Lubrication/Cleaning Fluid	6-10-33
Part Number	6-10-20
INVERSION VALVES (PRIMARY/SECONDARY FAN CLUTCH)	
Manufacturer	Bendix
Type	(Normally Open) TR-3

SECTION 6A2

RADIATOR & CHARGE-AIR MODULE (SERIES 60 ENGINE INSTALLATIONS)

(USED PRIOR TO 102DL3 UNIT 45959)

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 6A2-1
Components 6A2-1
Maintenance 6A2-4
Service Tools 6A2-22
Specifications 6A2-23

GENERAL DESCRIPTION

The Charge-Air-Cooling radiator module is one of the major components of the engine's cooling system. The module (Figure 1) composed of one coolant radiator assembly, one air cooler assembly, an air controlled shutter and fan clutch system, and mounting frame. The heat-dissipating capacity of the radiator assembly along with the fan control system should prevent the Series 60 engine coolant temperature from rising above the maximum allowable limit of 210°F (98°C). Additionally, the air cooler assembly assures proper air temperatures for optimum engine combustion, and provides for some alternate internal engine component cooling.

NOTE: The coolant's maximum temperature must not be exceeded by any engine operating condition, regardless of altitude, type of coolant used, or cooling system condition. Exceeding this limit can result in power-down safety sequence initiation, engine malfunction and/or serious damage.

As coolant circulates through the engine it gathers heat from the combustion process. The engine thermostat releases coolant, through the engine compartment's coolant piping system, to the radiator module where the heat transfer process takes place. The system uses air drawn over the radiator's finned tubes to achieve this process and reduce the coolant's temperature. The fan pulls air across the radiator through the curbside louvered panel, and radially expels it out the rear radiator door.

The fresh air is compressed and heated by the turbo-charging process. The turbocharger discharges this air into the Charge-Air-Cooling System's air cooler assembly, where air drawn over the cooler's finned tubes reduces the air's temperature, thereby, making it more dense. The heavier cooled air is pushed along by the turbocharger to the intake manifold. The Charge-Air-Cooler's fan pulls air across the exchanger through the roadside louvered panel, and radially expels it out the rear radiator door.

The Series 60 engine cooling system consists of several components working in conjunction to maintain a safe engine operating temperature. Because the Series 60 engine does not produce combustion heat in the amounts required to adequately heat the passenger and driver areas of the coach, an additional Webasto heater is installed to augment coach heating system (see Section 16D). Coolant for the Webasto heater is taken from the engine oil cooler, and routed to the center tunnel piping system. Coolant is returned to the engine's water pump inlet after completing heating circuit.

COMPONENTS

RADIATOR ASSEMBLY

The Charge-Air radiator/air cooler assembly is consists of a coolant radiator and an air cooler, complete with cores and vertical side reservoirs and mounting framework. The radiator and cooler are not joined together. The radiator and air cooler core designs are finned-tube cross-flow type. Coolant flow is from right (inlet) to left (outlet) and air flow is left to right, and maintained by the engine's water pump and turbocharger. The radiator's coolant side is fitted with a fan shutter assembly and shroud, whereas, the air cooler has only the shroud. Both are installed on the radiator module with air blocking foam seals.

MODULE FRAME ASSEMBLY

The module is located at the upper rear of the coach above the engine and below the coolant surge tank. Carbon steel construction is basic on the standard module support frame, while stainless steel construction is optional for corrosion resistance. The module is attached by fasteners to the coach's rear upper frame, and can be removed as a unit.

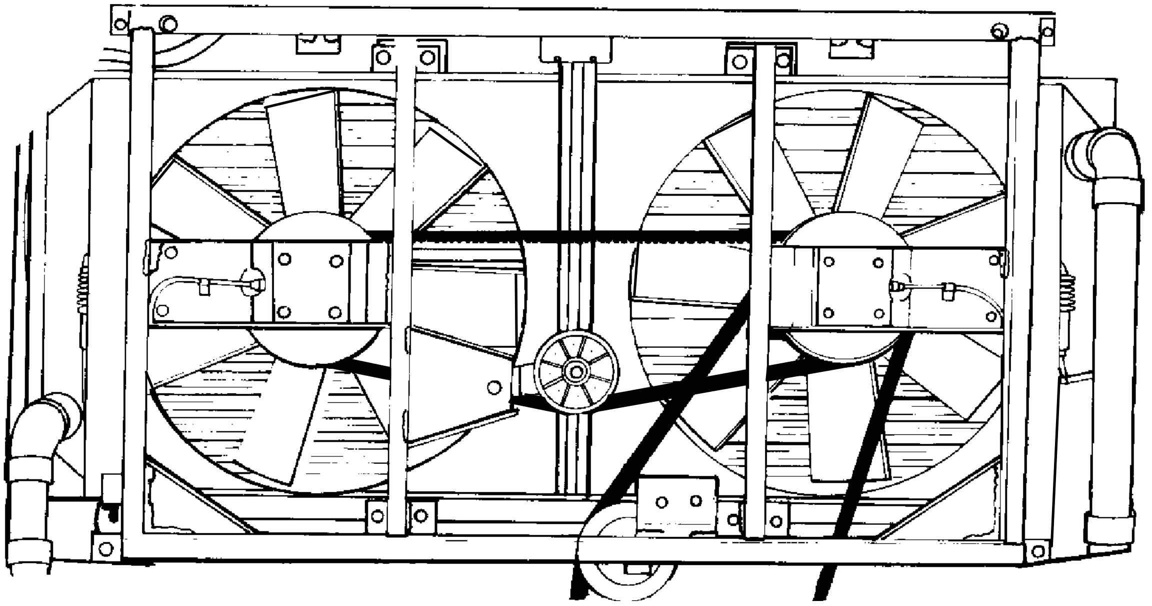

LEFT–HAND FAN CLUTCH
RIGHT–HAND FAN CLUTCH
SHUTTERS
SHUTTER CONTROL CYLINDERS
MODULE FRAME
FAN DRIVE BELT
FAN DRIVE BELT TENSIONING PULLEY
FAN CLUTCH TO CLUTCH BELT
FAN CLUTCH BELT TENSIONING PULLEY
8770

Figure 1. Radiator Module

CLUTCH FAN ASSEMBLY

The radiator module is fitted with twin air-operated coolant and intake manifold air temperature activated fan clutches. The coolant radiator side mounts a thirty-inch diameter seven-bladed reinforced nylon fan, while the air cooler has a twenty six-inch diameter fan. The clutch mechanism on both is an air-engaged piston-to-friction plate design. The coolant radiator's fan clutch engages through the shutterstat at 190°F, while the air cooler's fan clutch is engaged through the intake manifold temperature switch at 150°F and disengages at 120°F (Figure 2). Coolant radiator fan clutch application air is applied just after the shutter opens, and exhausted shortly after shutters begins to close.

At engine operating temperature the coolant radiator's fan clutch control system routes air to that fan as required. The air cooler's fan clutch control system allows for a cyclical operation dependent on inlet manifold air temperatures. Each control system maximizes the fan's ability to draw cool air across the radiator assembly sections as needed, while using the minimum amount of horsepower. The automatic function of the coolant radiator fan may be tested or by-passed by activating the test switch at module's lower right corner.

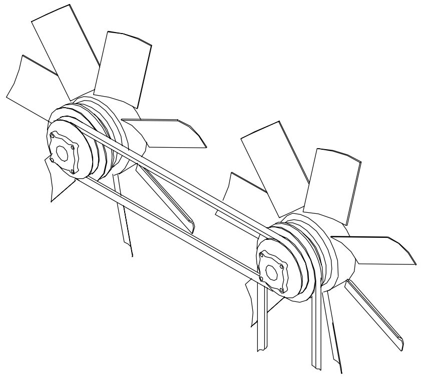


Figure 2. Fan Clutch Mechanism

The coolant radiator fan is driven by a single belt from the engine crankshaft pulley. The air cooler fan is single belt driven by the coolant radiator's fan clutch pulley.

Both belt drives incorporate a tensioning device and pulley assembly mounted to the module frame.

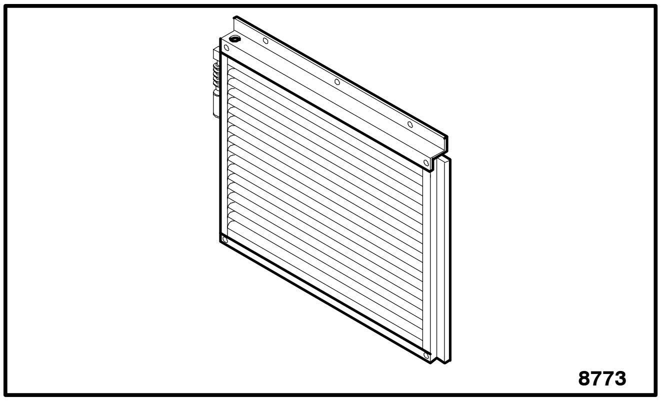


Figure 3. Shutters

SHUTTER ASSEMBLY

One air-operated spring-return shutter assembly is mounted to the coolant radiator on the exhaust side. The shutter assembly is independently operated by its own single-acting air cylinder (Figure 3). The actuation of the shutter cylinder is determined by the shutter control system. When air is applied to the normally open shutter assembly, it closes. Note that shutter closure begins before the coolant radiator fan clutch is disengaged, so that fan pressure dampens shutter closure. When closed by manual switch, the shutter (right hand only) allows coolant radiator fan-to-engine belt maintenance to be performed.

AIR CONTROLS

The air control system for the coolant radiator's fan clutch and shutter assembly automatically monitors and reacts to temperature changes within the engine-to-radiator coolant inlet tube. Additionally, the control system features manually operated fan/shutter test/by-pass and shutter close functions. The control system for the air cooler's fan clutch automatically monitors and reacts to temperature changes within the intake manifold, allowing for either fan induced or natural draft cooling. Both control systems' air is supplied through the shutterstat air filter assembly located below the module.

The coolant radiator control system components include a 190°F shutterstat, one inversion valve and two (2) air-diverting toggle switches. The normally open shutterstat mounts to the radiator inlet tube. The normally open inversion valve is mounted to the lower right side of module, and plumbed through the manually-operated switching array. The air-diverting toggle switches are mounted to a plate at the lower right front of the module.

The air cooler control system components include a temperature sensing electric switch, and a solenoid operated air valve. The normally closed switch mounts to the intake manifold. The normally open solenoid valve mounts to the lower left side of the module, and plumbed through the shutterstat air supply. Electrical power is supplied through the rear junction box.

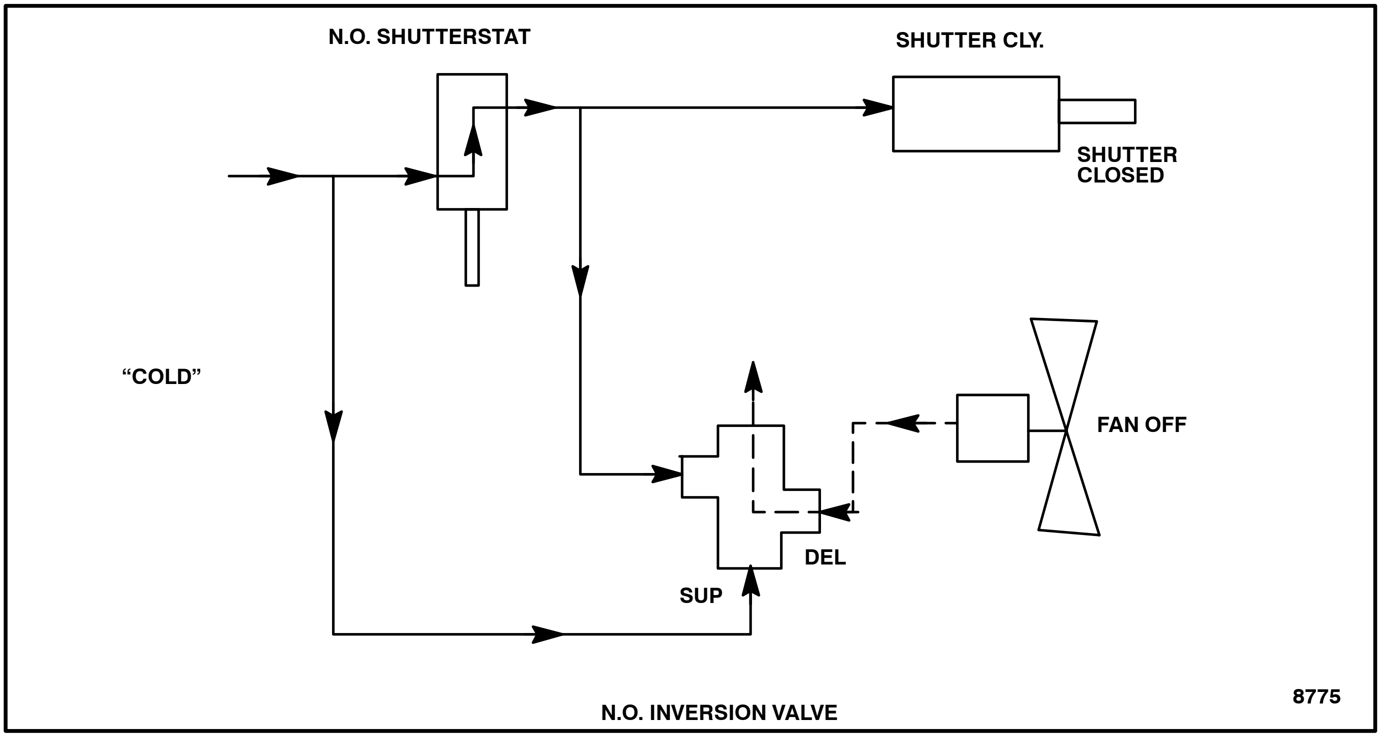


Figure 4. Air Flow Cold Radiator

At cold engine starting, the inversion valve's pilot port is pressurized, air from the inversion valve supply port is blocked, and the valve exhausts fan clutch to atmosphere (Figure 4). The air control system's design maximizes the module's ability to transfer heat, while using the minimum amount of horsepower.

As engine reaches stat's operating temperature of 190° F (Figure 5). The shutterstat should close, cutting air flow to the shutter cylinder and pilot port of the inversion valve. This allows the shutter cylinder and inversion valve pilot port lines to exhaust through the shutterstat, opening the shutter and the inversion valve supply-to-delivery port path, allowing inversion valve air supply to activate clutch.

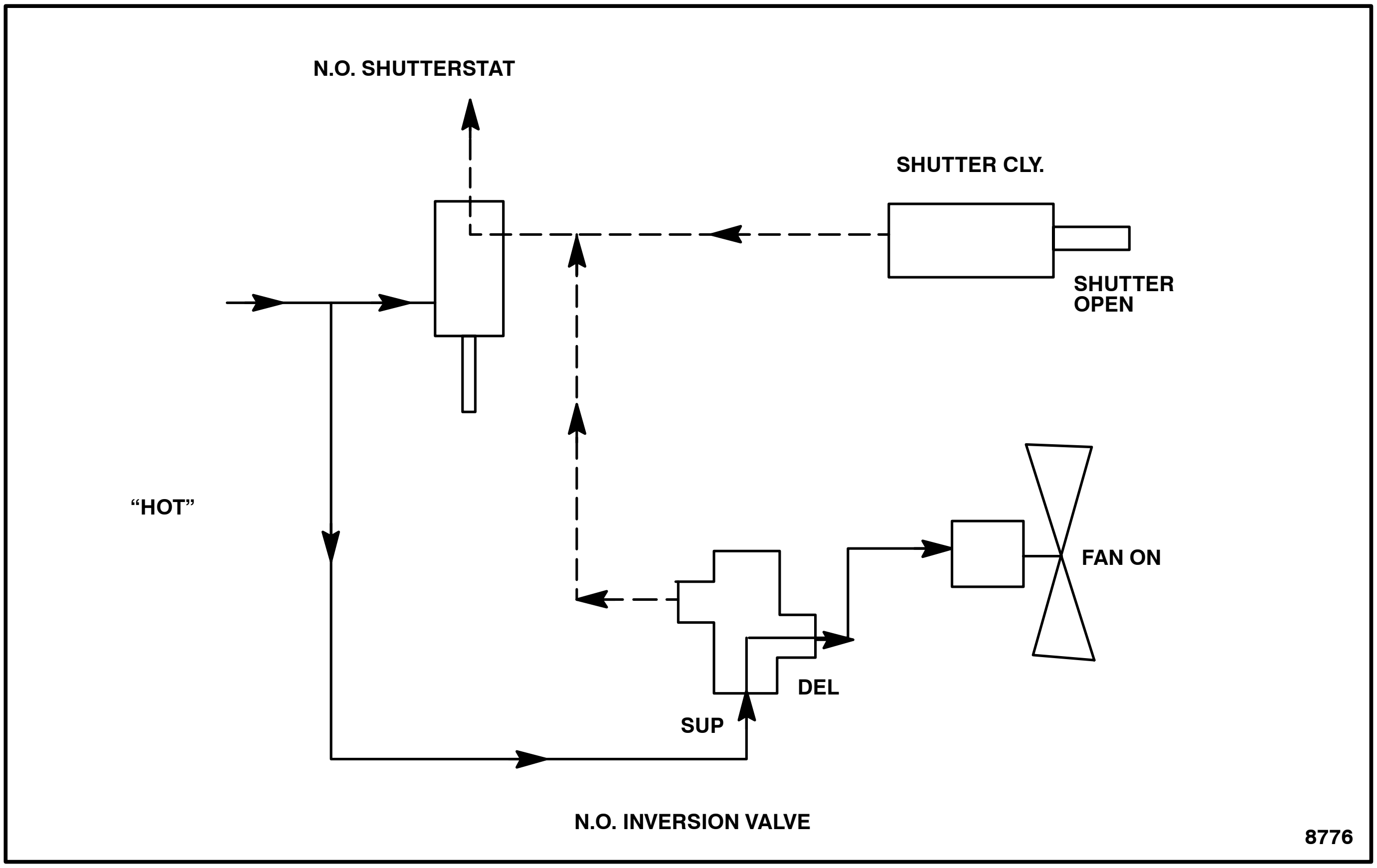


Figure 5. Air Flow Hot Radiator

When intake manifold air temperature reaches 150° F, the normally closed switch opens, stopping current to the solenoid valve. The normally open solenoid valve then allows air through to engage fan clutch. As temperatures drop to approximately 120° F, the switch should reset and complete circuit to solenoid valve, thereby blocking air flow to the clutch.

NOTE: If a low air situation or a complete loss of air pressure exists on the coach at engine start-up, the module's air control system may briefly exhibit some fan clutch engagement/disengagement and shutter function until coach air system fills to operating pressure.

MAINTENANCE

FAN DRIVE BELT ADJUSTMENTS

Proper belt tension (Figure 6) must be maintained on the engine-to-fan and fan-to-fan drives. Belts should be tensioned to the deflections shown, when force shown is applied at mid-span.

To adjust tension loosen hex head capscrew mounting tensioner assembly. Apply pressure to the belt by rotating tensioner assembly into the belt using a wrench on the 2 inch square of the tensioner base. When belt is properly tensioned, tighten the mounting bolt while holding the tensioner assembly in place. Mounting bolt torque should be 55-65 ft-lbs (74.6-88.1 N·m).

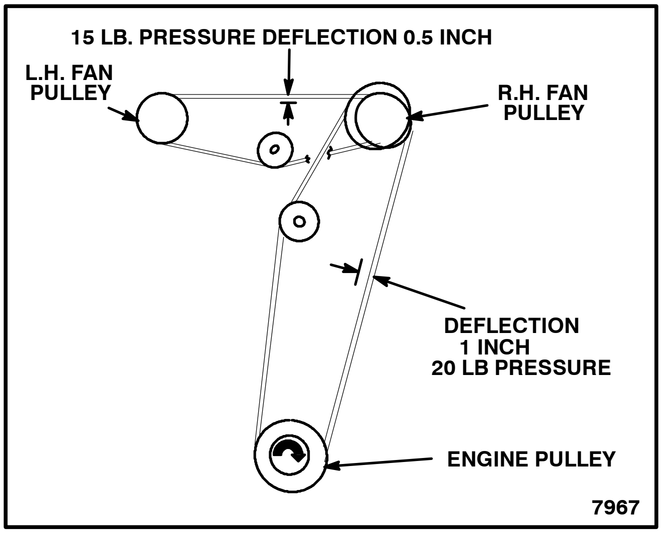

15 LB. PRESSURE DEFLECTION 0.5 INCH
L.H. FAN PULLEY
R.H. FAN PULLEY
DEFLECTION 1 INCH 20 LB PRESSURE
ENGINE PULLEY
7967

Figure 6. Drive Belt Tensioning

ENGINE-TO-FAN BELT REMOVAL

1. Loosen belt tensioner assembly.
2. Remove belt from sheave on engine crank pulley.
3. Close shutters on radiator using the switch located on module frame.
4. Slide belt between the fan and closed shutter using the notch located in the lower left-hand corner of the fan shroud to help work belt around fan blade.

INSTALLATION

Install belt by reversing procedure. When installing a new belt check and retension belt after 200 miles of operation and again at 2,000 miles of operation using "BELT ADJUSTMENT" procedure described eariler.

FAN-TO-FAN BELT REMOVAL

1. Loosen the belt tensioner assembly and remove the engine-to-fan belt from the engine drive pulley.
2. Loosen the tensioner on the fan-to-fan drive belt and remove.
3. Remove left-hand fan, clutch and frame assembly (see "RADIATOR MODULE DISASSEMBLY").
4. Remove belt from right-hand fan assembly using same procedure used to remove engine-to-fan drive belt.

INSTALLATION

1. Reverse procedure to install new fan-to-fan belt.
2. Reinstall fan frame assembly, See "RADIATOR MODULE ASSEMBLY" for proper assembly steps.
3. Tension belt to proper specification and recheck tension after 200 miles and 2000 miles of operation.

CLUTCH FAN ASSEMBLY

The air-actuated clutch mechanism on the Horton Diesltemp® requires some periodic maintenance (Figure 7). Every 25,000 miles (40,225 km) the clutch air chamber should be inspected for air leakage. If leaks are found follow the procedure for "O-ring and Face Seal Replacement". Additionally, it's recommended that every 350,000 miles (563,150 km) the procedure for "Major Overhaul" should be performed. Follow all procedures in the order in which they appear.

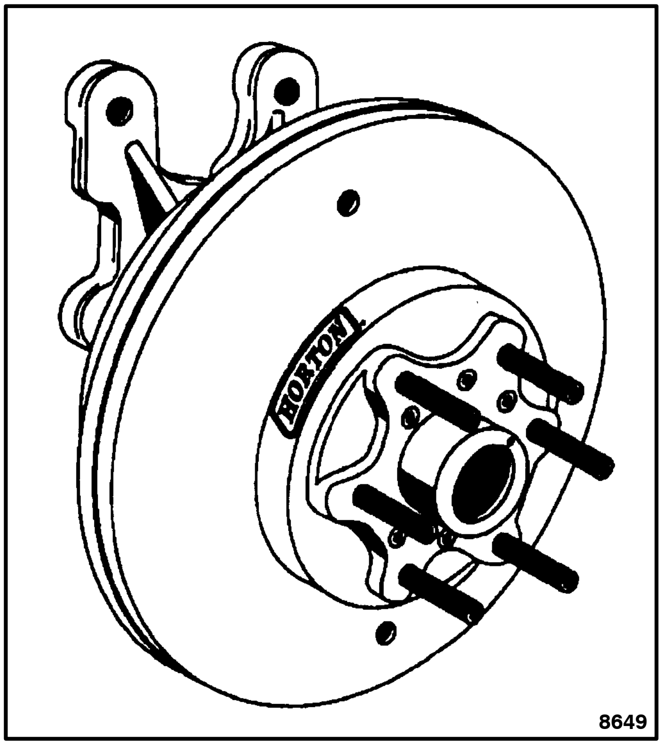


Figure 7. Clutch Mechanism

Clutch Fan Removal

1. Follow procedure for primary or secondary drive belt removals.
2. Unfasten and remove the clutch fan assembly from module frame.
3. Unfasten and remove nylon fan blade from clutch mounting hub.

Clutch Disassembly

1. Clamp fan clutch in vise.
2. Remove socket head fasteners from air chamber (Figure 8).

NOTE: Applying air pressure to clutch aids in removal of air chamber assembly from clutch. Attention must be exercised when using this procedure to prevent air chamber from popping off, resulting in personal injury.

3. Slide air chamber assembly off piston/friction disc.

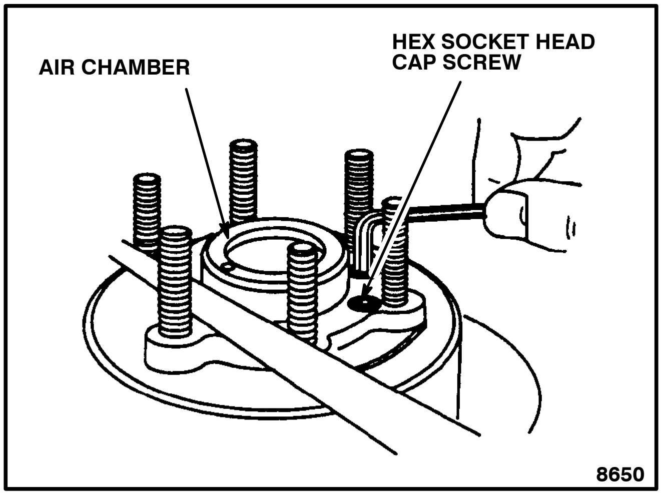


Figure 8. Clutch and Air Chamber Removal

4. Examine air chamber for signs of dirt or foreign matter.

⚠ CAUTION ⚠

Air chamber should be clean and dry. If not, a problem exists in the vehicle air system, and must be corrected before fan clutch is reinstalled. See “Shutterstat Filter” later in this section.

O-ring and Face Seal Replacement

1. Remove O-ring from air chamber and clean O-ring contact surfaces (Figure 9).
2. Remove and inspect face seal for signs of wear that may indicate dirt exists in air system.
3. Remove piston/friction disc and clean splines of both the friction disc and hub (Figure 10).
4. Apply an even coat of spline lubricant to hub (supplied with repair kit).
5. Install piston/friction disc.
6. Replace face seal and tighten to 50 in-lbs (5.7 N·m).
7. Lubricate new air chamber O-ring and O-ring contact surfaces with special O-ring lubricant (supplied with repair kit) and install.
8. Remove O-ring from piston/friction disc and clean O-ring contact surfaces (Figure 11).
9. Lubricate new piston/friction disc O-ring and O-ring contact surfaces with special O-ring lubricant (supplied with repair kit) and install.

NOTE: Entire tube of O-ring lubricant should be used.

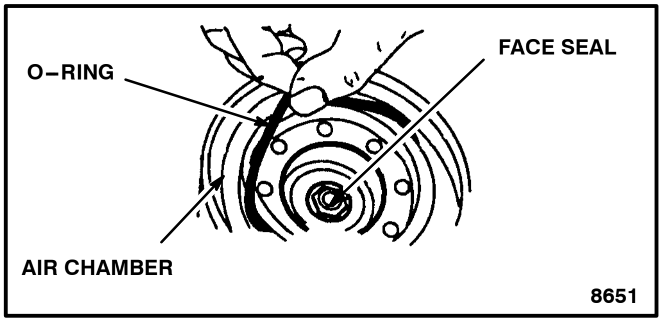


Figure 9. Small O-ring Removal

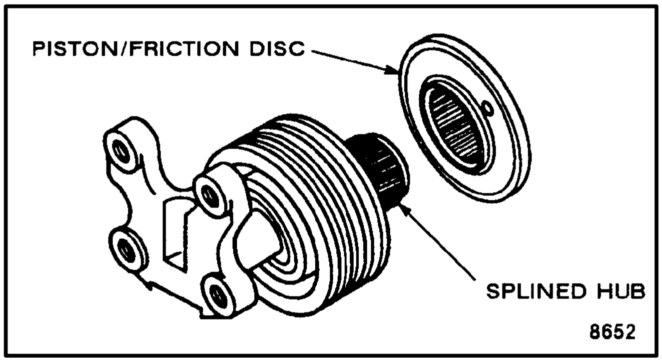


Figure 10. Friction Disc Removal

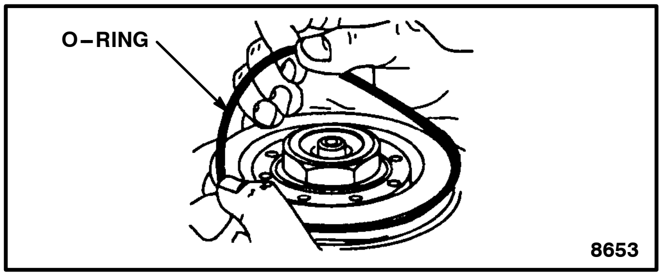


Figure 11. Large O-ring Removal

Air Cartridge Replacement

1. Remove air cartridge retaining ring from face seal (Figure 12).

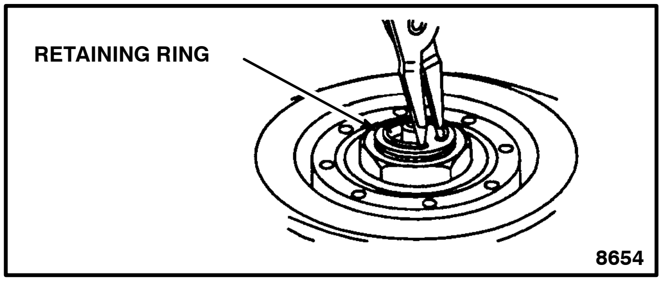


Figure 12 . Retainer Ring Removal

2. Remove cartridge assembly, O-ring and end cup (Figure 13).

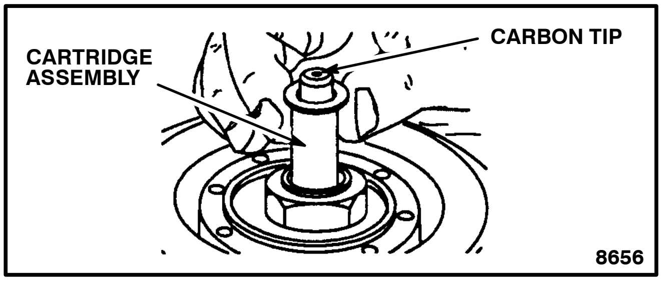

CARTRIDGE ASSEMBLY
CARBON TIP
8656

Figure 13. Cartridge Removal

3. Install new end cup (open end down), O-ring and cartridge assembly, and reinstall retaining ring (Figure 14).

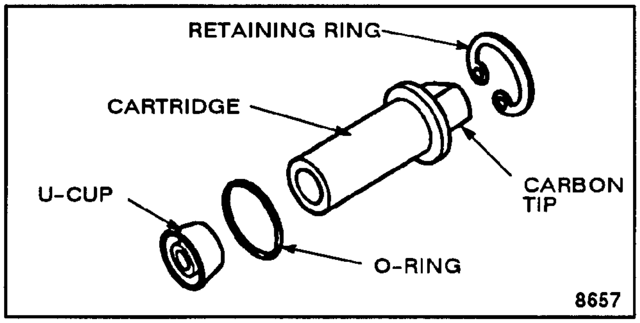

RETAINING RING
CARTRIDGE
U-CUP
CARBON TIP
O-RING
8657

Figure 14 . Cartridge Assembly

NOTE: Retaining ring must be fully seated in groove.

4. Clean carbon tip of cartridge assembly and face seal with clean dry cloth.

NOTE: A clean carbon tip and face seal is important for extended clutch life.

Clutch Assembly

1. Install air chamber onto piston/friction disc

NOTE: All clutch components must be cleaned and free of all rust and foreign material prior to reassembly.

NOTE: Extreme care should be exercised when replacing the air chamber to avoid damage to O-rings.

2. Install and tighten socket head fasteners to 180 in-lbs (20.3 N·m).

3. Apply 90 to 120 p.s.i. of clean air to clutch to check for proper engagement, and verify that there are no air leaks.

Major Overhaul Dissassembly

1. Follow the procedure for “Clutch Fan Removal” and “Clutch Disassembly”.

2. Remove locknut retaining hub to journal (Figure 15).

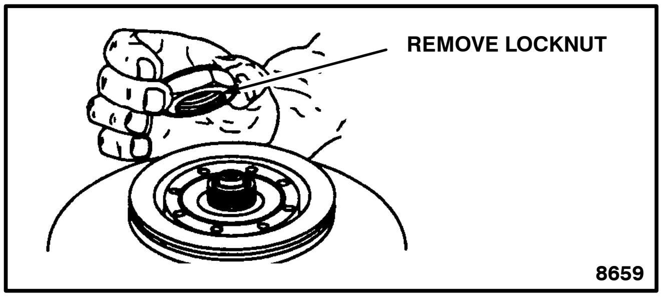

REMOVE LOCKNUT
8659

Figure 15. Locknut Removal

3. Remove spacer, seal and piston/friction disc assembly from splined hub.

4. Slide splined hub off journal bracket (Figure 16).

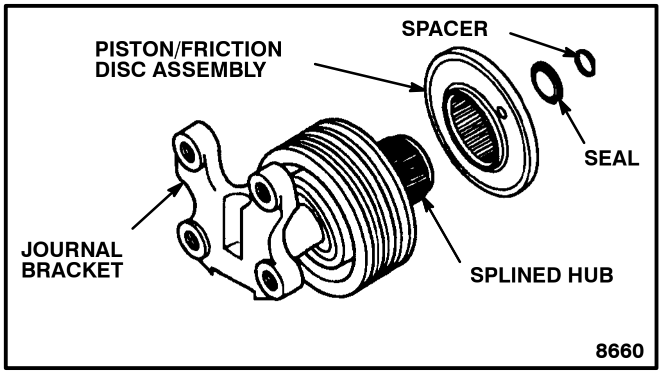

SPACER
PISTON/FRICTION DISC ASSEMBLY
SEAL
JOURNAL BRACKET
SPLINED HUB
8660

Figure 16. Hub Removal

Bearing Replacement

1. Remove journal spacer between hub and sheave (Figure 17).

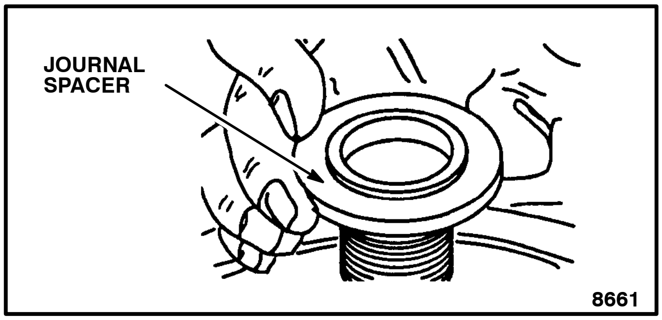

JOURNAL SPACER
8661

Figure 17. Journal Spacer Removal

2. Slide sheave off journal bracket spindle (Figure 18).

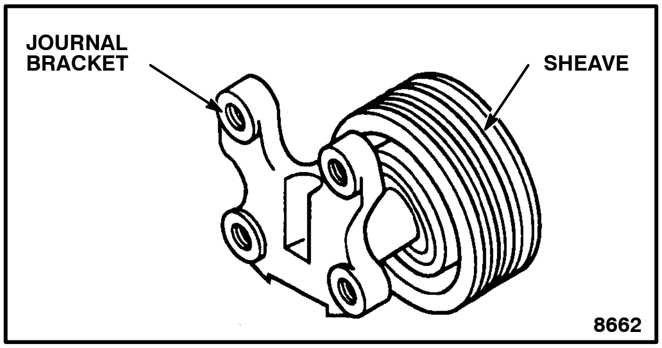

JOURNAL BRACKET
SHEAVE
8662

Figure 18. Sheave Removal

3. Support sleave for bearing removal, and press both bearings out of sheave (Figure 19).

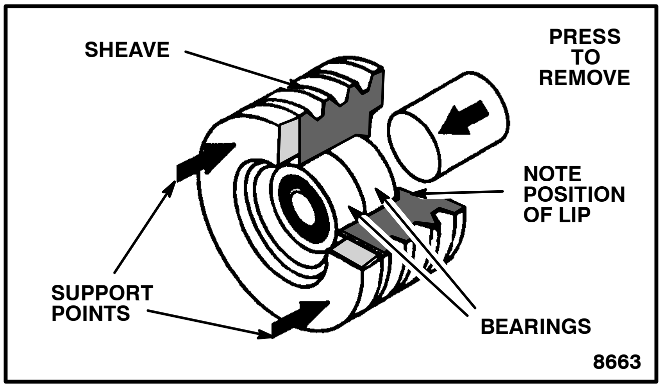

SHEAVE
PRESS TO REMOVE
NOTE POSITION OF LIP
SUPPORT POINTS
BEARINGS
8663

Figure 19. Bearing Removal

NOTE: Some clutch models contain spacers between bearings (Figure 20).

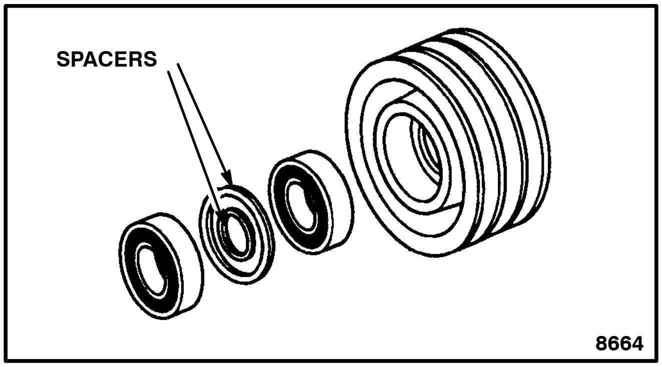

SPACERS
8664

Figure 20. Bearing Spacer Location

4. Position new bearings and press into place (Figure 21).

NOTE: All bearings are prelubricated and sealed, do not remove seals to lubricate.

Friction Facing Replacement

1. Inspect friction facing and replace if worn to 1/16 inch (1.6 mm) thickness, oily, or burnt.

2. Unfasten and remove button head capscrews, and remove friction facing (Figure 22).

3. Install new friction facing and tighten fasteners to 35-40 in-lbs (4.4-4.5 N·m).

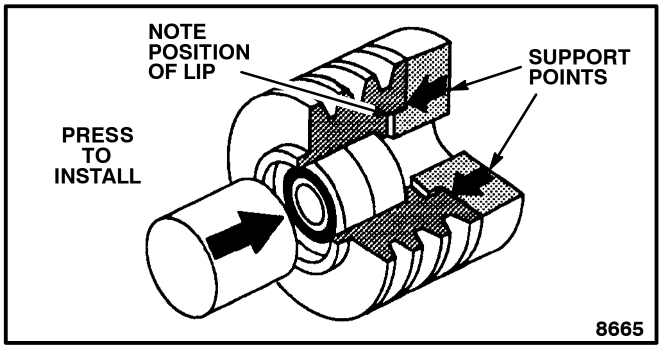

NOTE POSITION OF LIP
SUPPORT POINTS
PRESS TO INSTALL
8665

Figure 21. Bearing Installation

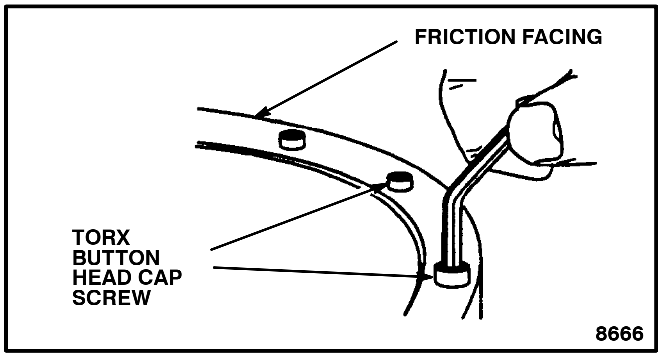

FRICTION FACING
TORX BUTTON HEAD CAP SCREW
8666

Figure 22. Friction Face Removal

4. If required proceed with procedures for “Air Cartridge Replacement” and/or “O-ring and Face Seal Replacement”.

Major Overhaul Assembly

1. Slide sleave onto journal bracket spindle.
2. Install journal spacer.

NOTE: Install journal spacer with lip facing toward front of clutch.

3. Clean and Lubricate hub splines if “O-ring and Face Seal Replacement” procedure was not done.

4. Slide splined hub assembly onto journal bracket spindle.

5. Install seal and spacer onto journal bracket spindle.

6. Replace locknut and tighten to 150 ft-lbs (203 N·m).

7. Slide piston/friction disc assembly onto splined hub

8. If “O-ring and Face Seal Replacement” was done, refer to procedure for “Clutch Assembly.”

9. Replace and tighten socket head fasteners to 180 in-lbs (20.3 N·m).

10. Reverse the procedure for “Clutch Fan Removal”, and install fan drive belts.

SHUTTER ASSEMBLY

The air-actuated shutter assembly requires very little maintenance. However, in addition to the normal lubrication provided by the filter, it’s recommended that the shutter air cylinder’s piston and seals be lubricated with a silicon base lubricant every 50,000 miles (80,450 km). This is accomplished by disconnecting the air tubing and spraying a small amount of lubricant into cylinder inlet port. Work shutter through a few cycles with clean dry air and reconnect control system air.

If shutter should every need repair, follow the procedure for removing shutter assembly from radiator assembly later in this sub-section. The following procedure should be followed for replacement of blades, control rods or air cylinders.

1. With shutter’s exhaust side flat on table, remove lower cylinder attaching bolt.
2. Remove cylinder rod end E-clip retainer and slide cylinder off actuator rod.
3. Unfasten and remove shutter return springs.
4. Unfasten and remove frame retaining bolts at each corner.
5. Remove E-clips retaining blades and/or control rod and replace damaged parts

NOTE: Make note of locations where E-clips are placed for reassembly.

6. Reverse procedure, and install onto radiator assembly per procedure.

AIR CONTROLS

Most of the air control system components (Figures 23 and 24) require little maintenance, and some components are so designed as to be unrepairable. Items such as plastic tubing, fittings, shutterstat, temperature switch and air diverting switches should be considered throw-away items once they are found to be unfit for service. Components that do demand some periodic service and/or maintenance are the Bendix inversion valves, Kysor shutterstat filter and the Skinner solenoid valve.

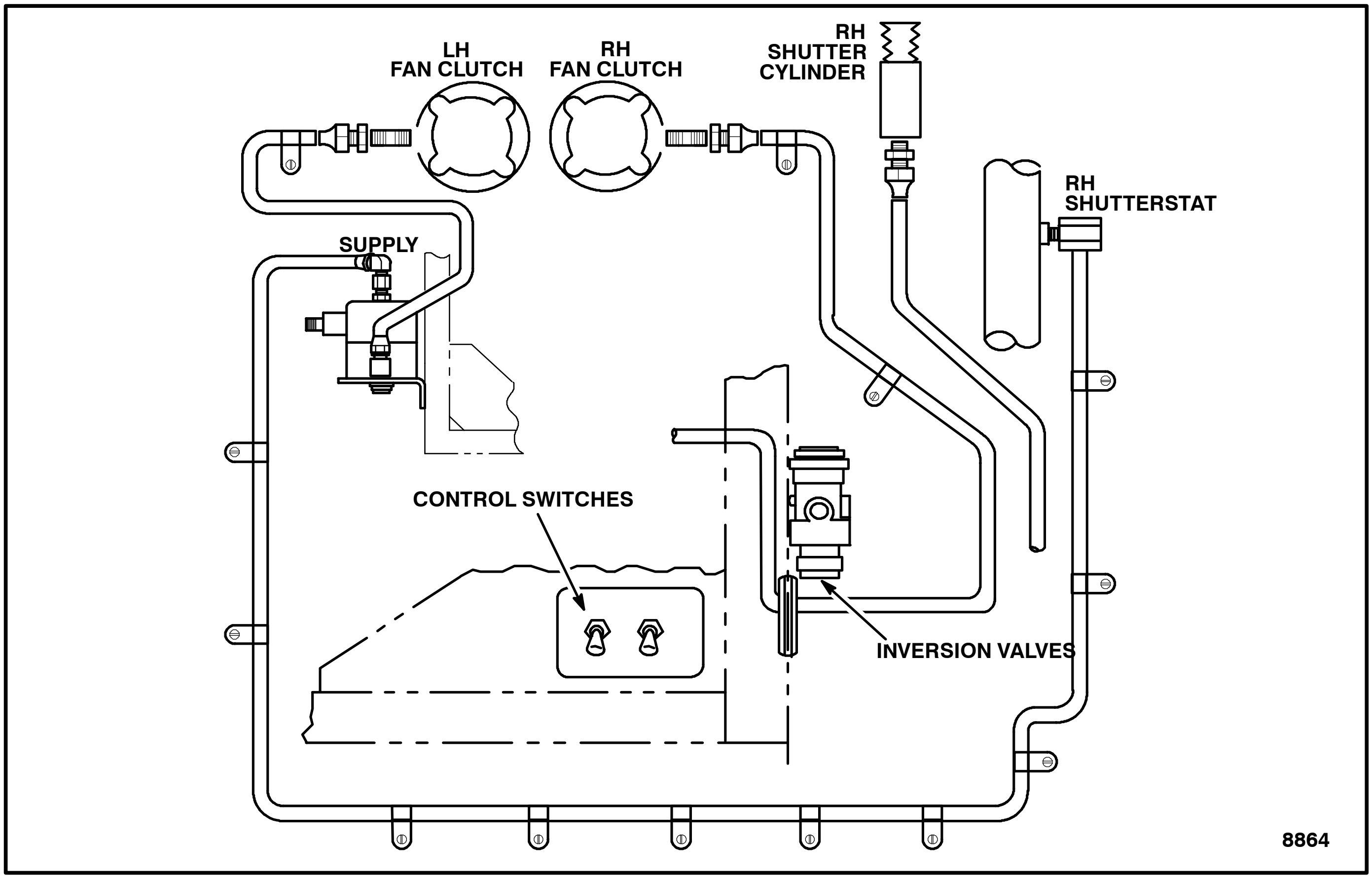


Figure 23 . Control System Components

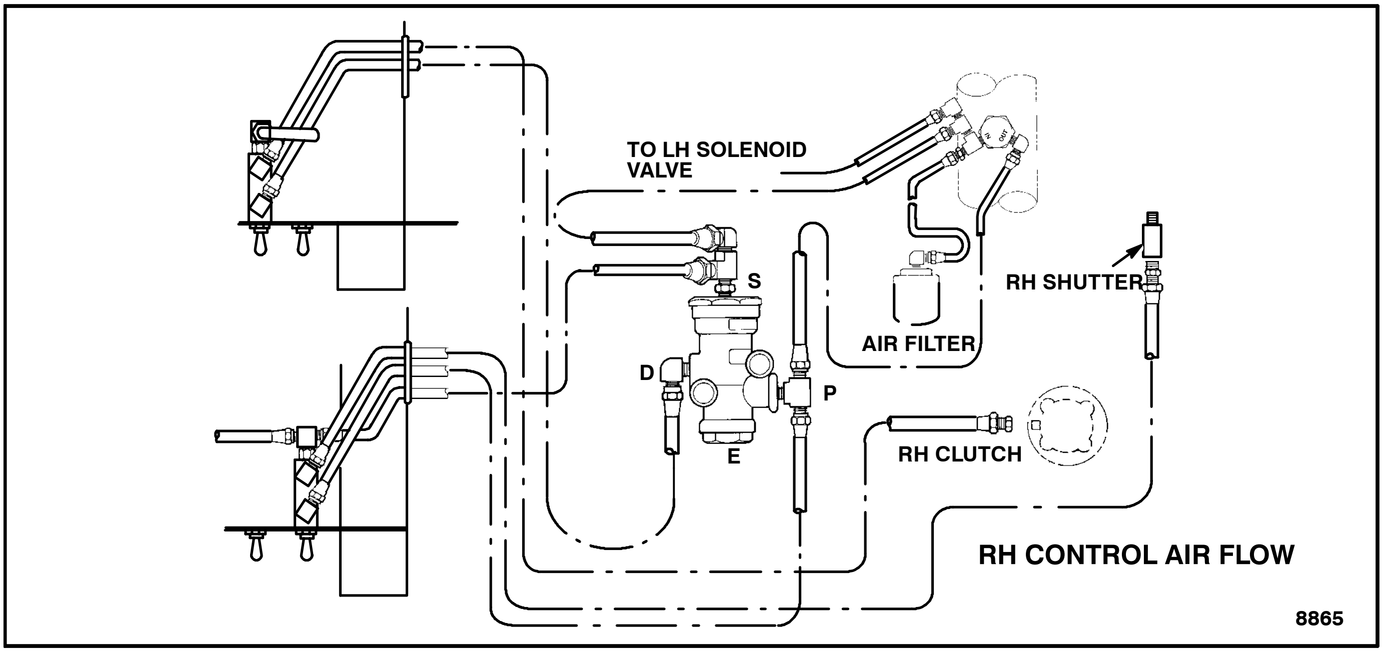


Figure 24. Right Hand Air Flow

Every 100,000 miles (160,900 km) or each 3600 operating hours the inversion valve (Figure 25) should be disassembled, cleaned and inspected. The exhaust seat and inlet seat should be checked for nicks or burrs. Inspect all rubber parts for signs of cuts, abrasion, swelling or deterioration, and replace if necessary. Follow the disassembly/assembly procedures in order.

At intervals of 3,000 miles (4,800 km), one ounce (28 ml) of Kysor Air Filter Fluid (PN 6-10-33) should be added to the filter. Remove the plug on the top of the filter body, add fluid and replace the plug. At intervals of 10,000 miles (16,000 km) the air filter should be disassembled and the felts cleaned with commercial solvent or replaced (Figure 26). When reassembling the filter use new gaskets.

Part of the weekly maintenance procedure should be to drain the filter by opening the draincock at the bottom of the filter body while the filter is under pressure. During cold weather operation, the filter should be drained daily.

Every 100,000 miles (160,900 km) or each 3600 operating hours the solenoid valve should be disassembled, cleaned and inspected. The plunger, spring, piston and seals should be checked and replaced if necessary. Follow the disassembly/assembly procedures in order.

Shutterstat Replacement

Before the shutterstat can be removed and replaced, it will be necessary to drain the engine coolant to a level below the stat to be removed. Refer to “Draining Cooling System” later in the section for procedures.

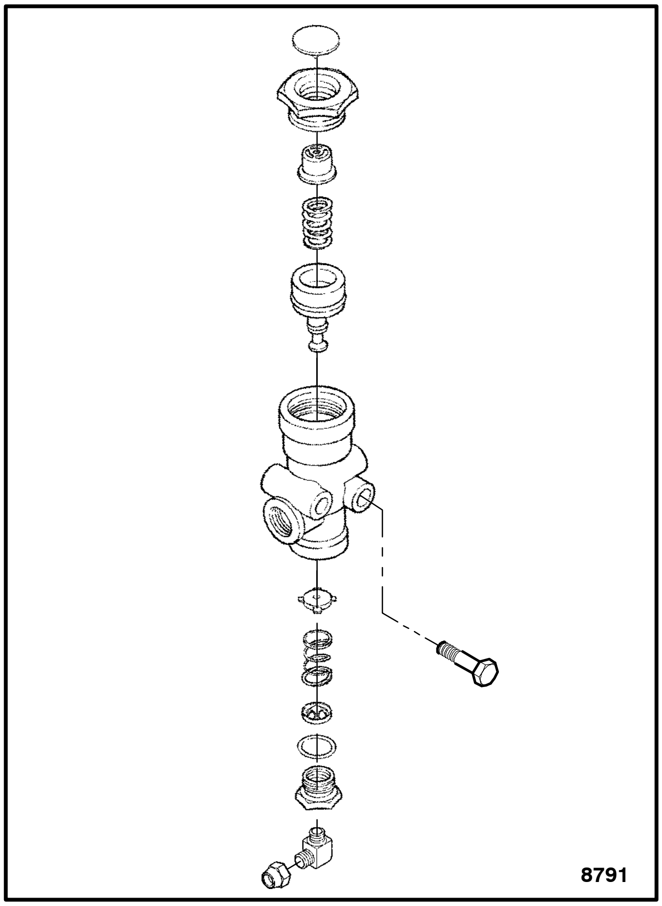


Figure 25 . Inversion Valve

1. Disconnect the shutterstat air lines, plug and tape mark them to prevent contamination and to correctly locate at assembly.

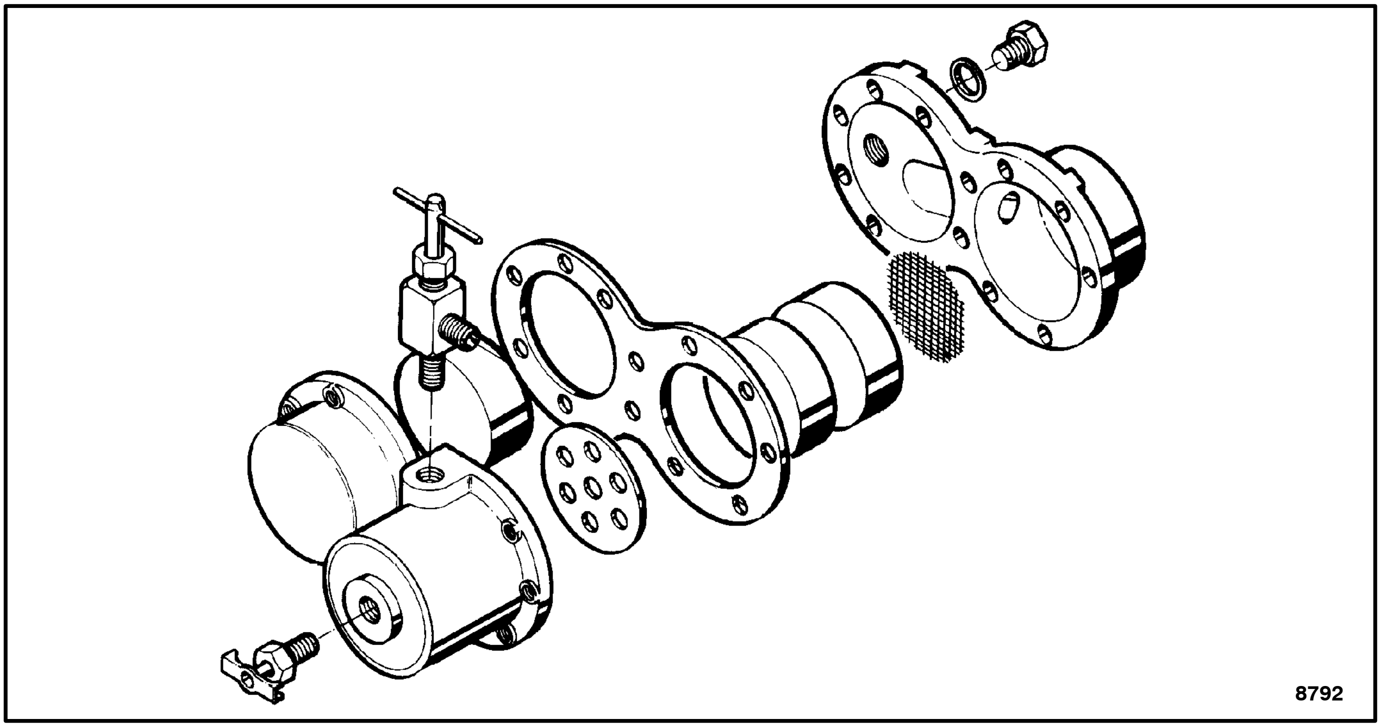


Figure 26. Shutterstat Filter

2. Unscrew and remove the shutterstat.

NOTE: The shutterstat is non-serviceable and should be discarded.

3. Install new shutterstat, and reconnect the air lines.

4. Refill the cooling system, and check shutterstat's function at engine operating temperature.

Air-Diverting Switch Replacement

1. Disconnect the switch air lines, plug and tape mark them to prevent contamination and to correctly locate at assembly.

2. Unfasten and remove hex nut and lockwasher that mount switch to plate.

NOTE: The switch is non-serviceable and should be discarded.

3. Install new switch, and reconnect the air lines.

4. Check clutch and shutter function at engine operating temperature.

Inversion Valve Disassembly

1. Disconnect and mark for installation all air lines.
2. Unfasten mount bolts and remove valve from radiator assembly.
3. Remove exhaust port cap nut and O-ring.
4. Remove diaphragm retainer and piston spring.
5. Remove any shims or washers if present.
6. Remove piston from body.
7. Remove piston O-ring and exhaust stem O-ring.
8. Remove supply cap nut and O-ring.
9. Remove valve stop and spring.
10. Remove inlet and exhaust valve.

NOTE: Care should be taken if clamping valve in vise. Excessive force can cause distortion of valve body.

Cleaning and Inspection

Wash all metal parts in a good cleaning solvent.

Wipe all rubber parts clean.

Inspect all parts for signs of wear or deterioration.

Check springs for cracks, corrosion, or distortion.

Inspect piston and its exhaust seat, body bores, and inlet valve for nicks, scratches, or burrs.

Replace all parts not considered serviceable during inspection.

Inversion Valve Assembly

1. Install inlet and exhaust valve in body (supply port).
2. Install inlet valve spring and valve stop (center stop on spring).
3. Install O-ring on supply cap nut and install and tighten cap nut to 100 in-lbs (11.4 N·m)
4. Install piston and exhaust stem O-ring on piston.

> **NOTE:** Before assembling the valve, lubricate the piston O-rings and body bores with Bendix silicone lubricant P/N 291126 or equal.

5. Install piston into body.

6. Install shims or washers if used.

7. Install piston spring.

8. Install diaphragm retainer and exhaust diaphragm.

9. Install O-ring on exhaust cap nut and install and tighten nut to 275 in-lbs (31.4 N·m).

10. Test the rebuilt valve per the “Operating and Leakage Test” that follows.

Operating and Leakage Test

> **NOTE:** The following checks should be made with two test gauges known to be accurate.

Install one test gauge in a common control and supply line; install the other gauge in the delivery port. Gradually apply pressure to the common supply and control (pilot) lines. On ascending pressure, note at what pressure exhaust occurs and compare with stated pressure. With supply and control ports pressurized, apply a soap solution around the supply port cap nut. No leakage is permitted. Apply soap solution to the delivery and exhaust ports, a slight bubble leakage is permissible. Excessive leakage would indicate a faulty O-ring or inlet valve. Slowly decrease pressure in the control cavity and note at what pressure delivery is made and compare to stated pressure.

Solenoid Valve Disassembly

1. Turn battery disconnect switch off.

2. Disconnect electrical harness from valve terminals.

3. Bleed off air pressure at valve, and disconnect supply and application air lines.

4. Unfasten and remove valve from module assembly.

5. Remove the sleeve adapter,adapter seal, housing nut, nameplate and housing.

6. Remove coil assembly from housing if necessary.

7. With special skinner wrench nut, remove sleeve from body

CAUTION

Never use a wrench on the sleeve itself.

8. Remove spring, plunger and flanged seal from body

> **NOTE:** Wash plunger assembly, seals and O-rings in mild soap and water solution only.

9. Apply mineral oil to the flanged seal, and reinstall into valve body.

10. Install plunger and spring in sleeve, and tighten sleeve into body with wrench nut to 135 in-lbs (15.4 N·m).

11. Install coil into housing, and assembly housing components in reverse order tightening nut to 35 in-lbs (4.1 N·m).

12. Reinstall onto module assembly.

13. Connect air lines and electrical harness.

14. Turn battery switch on, start engine, and test valve’s operation.

RADIATOR ASSEMBLY

It is essential that the radiator cores be kept free from corrosion and debris, and that regular maintenance be performed in conjunction with the other components of the cooling system. See sub-section on “Coolant” later in the section for further details.

As there are no moving parts on the radiator assembly, no set interval for service, aside from that specified for coolant is necessary. However, inspection of the air seals, and fasteners of attaching components should be made at the coolant inspection or test intervals.

RADIATOR MODULE REMOVAL

1. Turn battery switch off.

2. Drain cooling system (see “DRAINING COOLING SYSTEM”).

3. Disconnect radiator door stop lamp wiring.

4. Position a lift or stand to support the rear radiator door at removal.

5. Remove trim molding above radiator door.

> **NOTE:** Two people are required (hold ends of trim to prevent breaking).

6. Remove trim panel across top of radiator door opening.

7. Disconnect door air springs from frame and tyrap to door.

8. Unfasten and remove the radiator door hinge-to-frame bolts, and remove door.

9. Unfasten and remove the curbside louver panel. Remove two screws (2) at rear and side (Figure 27). In some cases both louvered panels may need to be removed.

> **NOTE:** Two people may be necessary to remove panel. Retain all rubber washers and fasteners

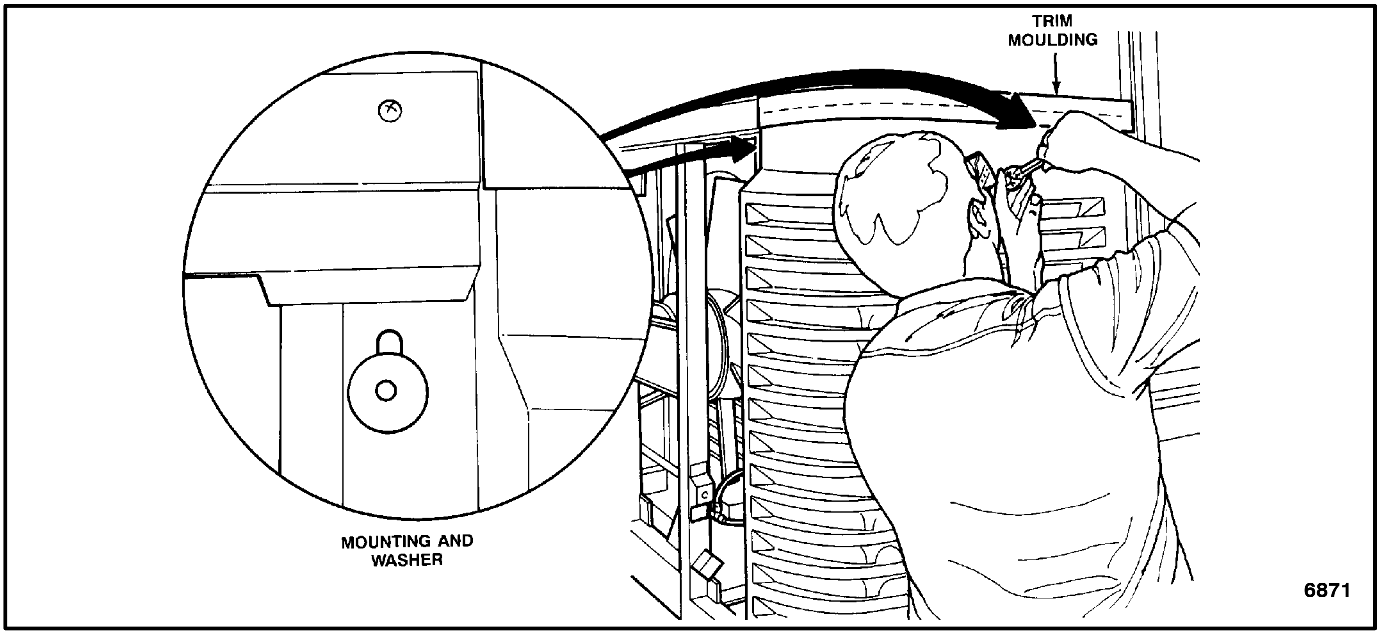


Figure 27. Louvered Panel Removal

10. Remove left/right engine compartment doors.

A. Disconnect license plate wiring.

B. Disconnect door prop rods.

C. Remove door hinge mounting bolts, and remove doors.

NOTE: Two people are required to remove doors.

11. Loosen and remove engine-to-fan drive belt from idler pulley, and stow belt out of way in module.

12. Disconnect and remove coolant radiator outlet tube.

13. Disconnect and remove the air cooler's inlet tube section from turbocharger housing outlet.

14. Disconnect and remove air cooler's outlet tube section to intake manifold.

15. Disconnect and remove thermostat outlet tube from radiator inlet tube and thermostat housing.

16. Cover engine thermostat housing outlet to prevent debris from entering the cooling system.

17. Loosen the air line on top of the shutterstat air filter and let the pressure bleed off. Disconnect airlines.

18. Disconnect the control system's air supply line from filter to shutterstat.

⚠ WARNING ⚠

Wear proper eye protection. Be careful that air pressure does not blow debris into eyes when disconnecting the air supply line.

19. Disconnect and remove the inlet radiator tube.

A. Disconnect bracket holding radiator inlet tube.

B. Loosen clamp at top of inlet radiator tube, pull free, twist tube 180 degrees to right, pull up, swing top down, to right and remove (Figure 28).

NOTE: Insert plug to prevent remaining coolant in the radiator from spilling.

20. Disconnect the solenoid valve's air supply line from shutterstat and electrical harness from switch.

21. Remove aerator line from top of coolant radiator, and stow out of way.

22. Unfasten and remove radiator module to coach frame mounting bolts.

23. Measure distance between vertical frame members and cut a spreader board approximately 1/2 inch longer. Set the board flat against the top left engine door mounting bolt and drive board up until approximately horizontal with opening. This will spread rear frame verticals to allow easier removal of the radiator module (Figure 29).

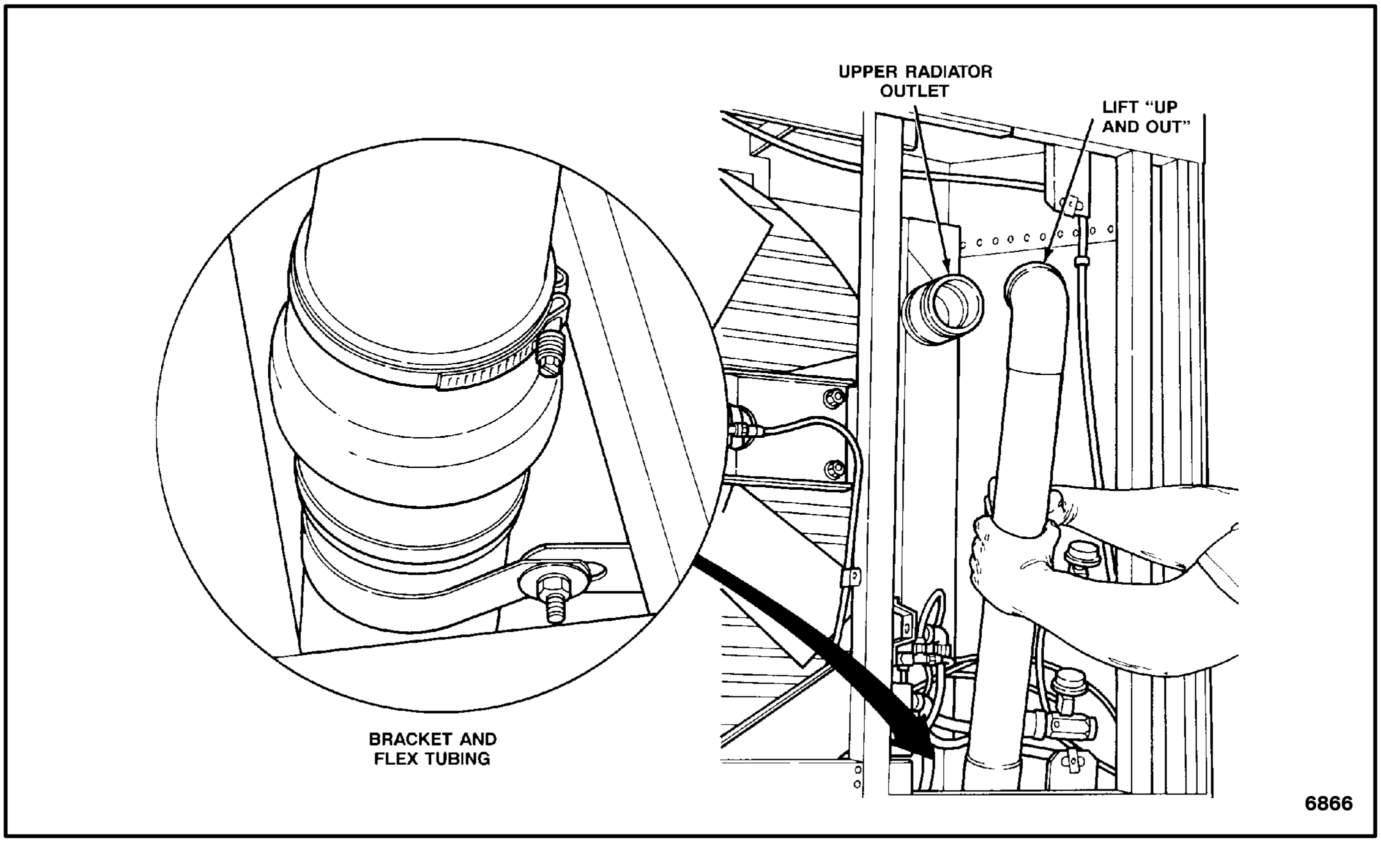

UPPER RADIATOR OUTLET
LIFT "UP AND OUT"
BRACKET AND FLEX TUBING
6866

Figure 28 . Inlet Tube Removal

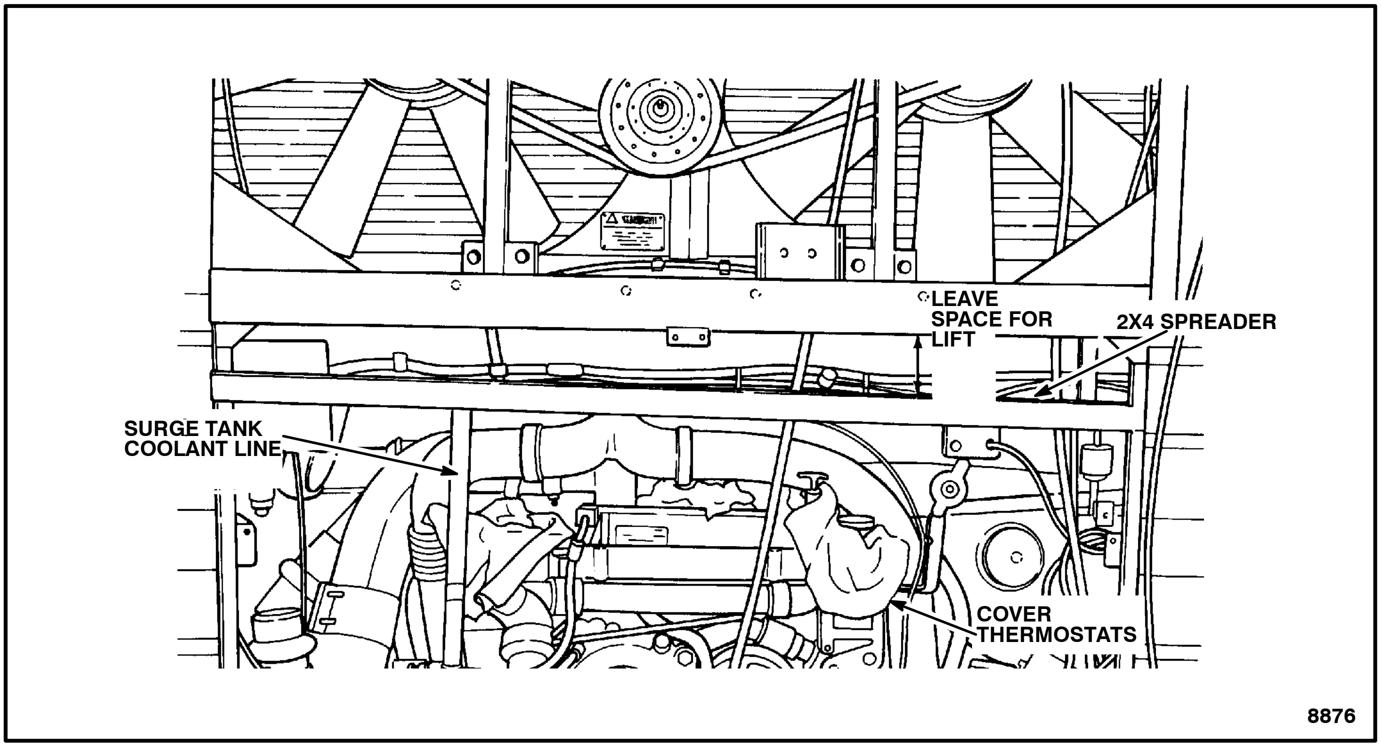

LEAVE SPACE FOR LIFT
2X4 SPREADER
SURGE TANK COOLANT LINE
COVER THERMOSTATS
8876

Figure 29. Spreader Placement

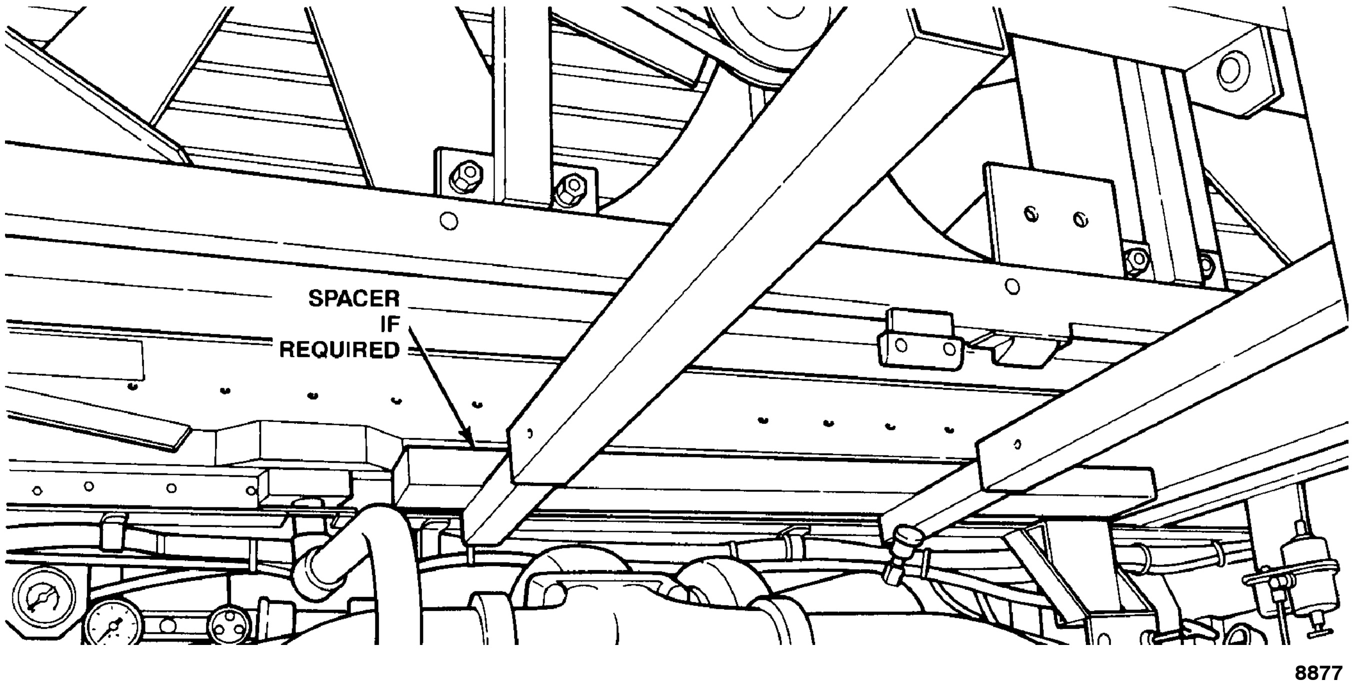


Figure 30. Lift Placement

NOTE: The surge tank line may have to be loosened to insert the spreader.

24. Place lift in position and raise enough to place pressure against bottom of module (Figure 30).

⚠ CAUTION ⚠

Be careful that the lift does not damage ether cup assembly on filter housing or other engine parts.

25. Clamp or fasten the radiator module to the lift (Figure 31).

NOTE: Three people are required to pull the module out of the radiator compartment (Figure 32) two people to work the module loose and the third to operate the lift).

NOTE: Pry bars may be necessary. Use heel bar driven between the mounting brackets to loosen the module. If necessary remove bolts in top stabilizer bars and replace bolts after clearing the coach frame.

⚠ CAUTION ⚠

If spacers have been placed between the module frame and the coach frame for spacing at the lower mounting brackets, remove them before pulling the module out. Mark locations of spacers and save for re-use.

⚠ CAUTION ⚠

DO NOT drag the module's bottom while removing from coach.

26. Remove drain plug from radiator and drain remaining coolant.

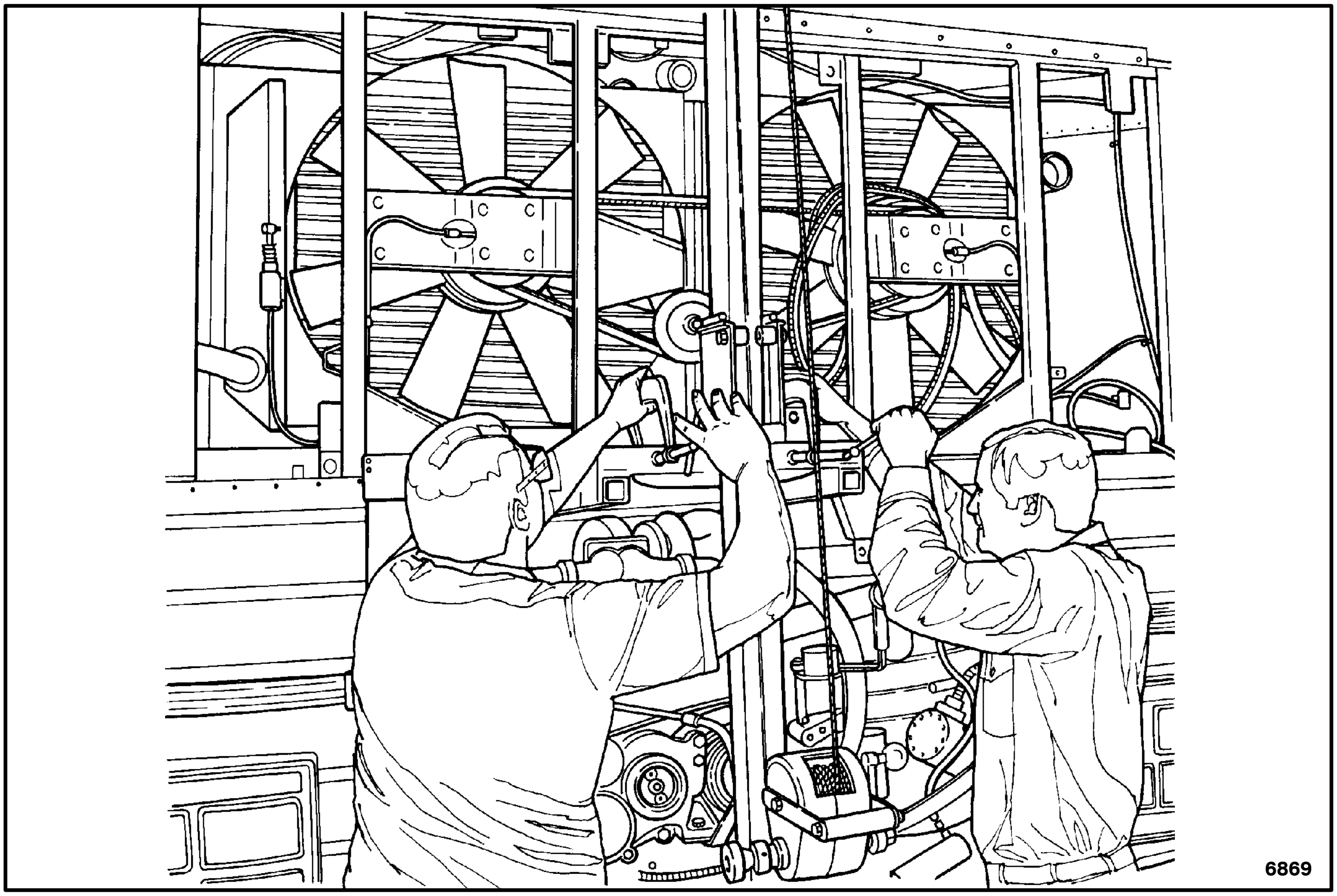


Figure 31. Clamp Module to Lift

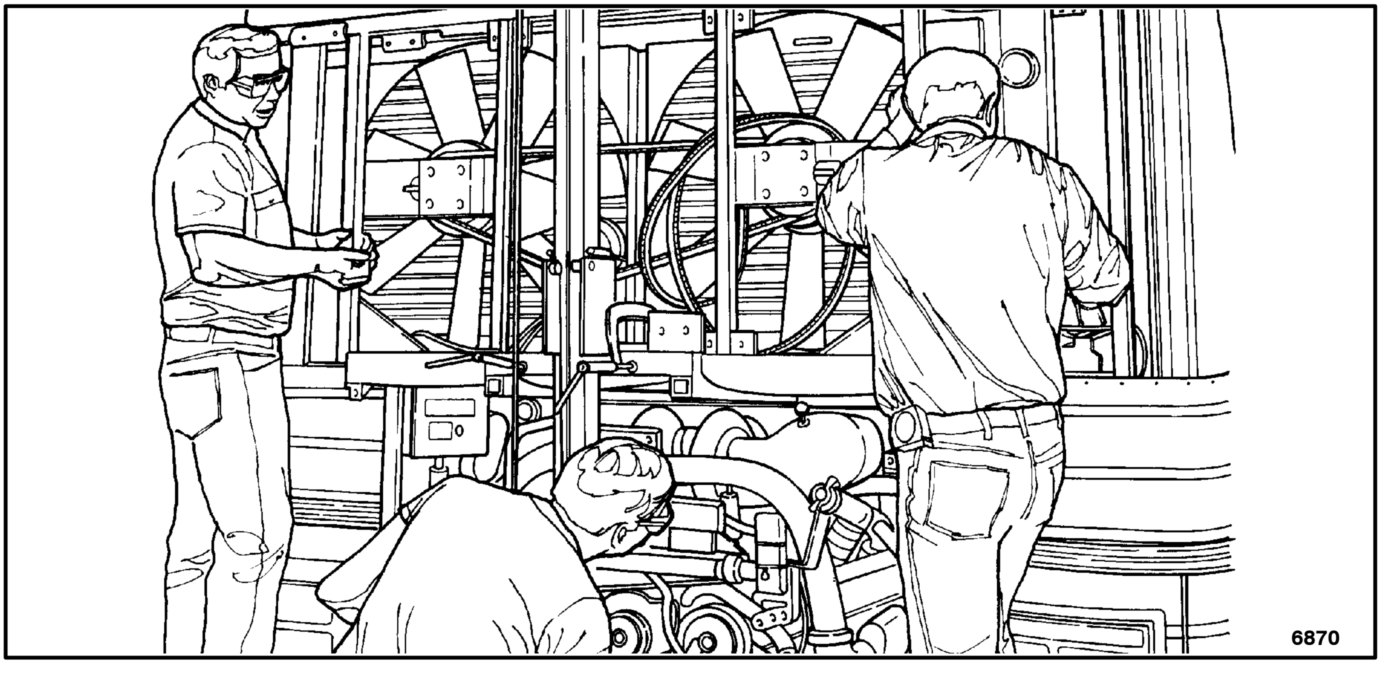


Figure 32. Removing Module

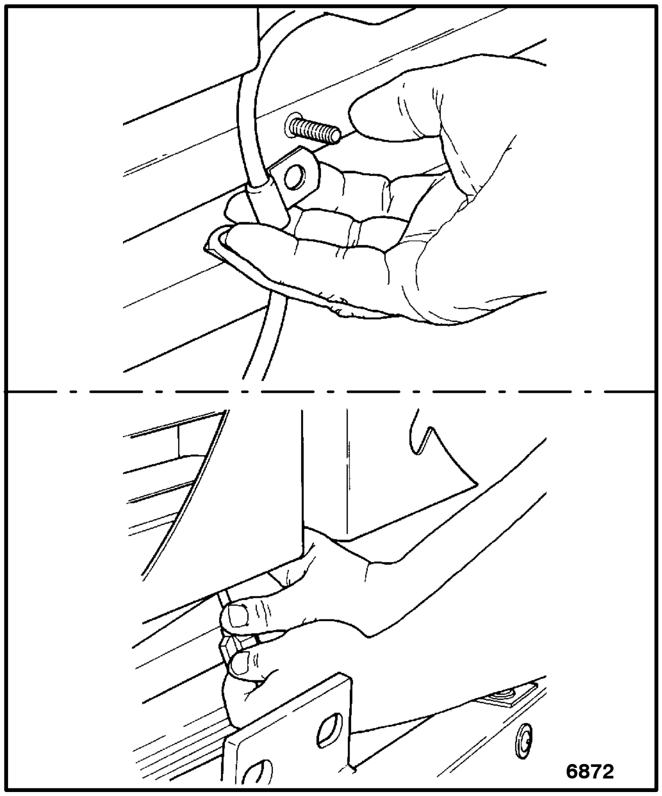


Figure 33. Clamp and Air Line Removal

RADIATOR MODULE DISASSEMBLY

1. Remove air line clamps (Figure 33).
2. Disconnect fan clutch and shutter cylinder air lines.
3. Disconnect and remove fan-to-fan tensioner/idler pulley.
4. Disconnect and remove radiator/cooler fan clutch assemblies and their mount brackets(Figure 34).

NOTE: Procedures #1 thru #4 may be completed during "Radiator Module Removal"

5. Check both seals on front of radiator and remove if damaged or hard.
6. Remove radiator/cooler mounting bolts.
7. Remove stabilizer bars (Figure 35)

NOTE: Two people are required to steady radiator/cooler assembly when stabilizer bars are removed.

8. Remove the coolant radiator/air cooler assembly from the module (Figure 36) and lay on bench, shroud/shutter assemblies up.

RADIATOR/COOLER DISASSEMBLY

1. Unfasten and remove radiator/cooler shrouds from shutter assembly and air cooler frame.
2. Unfasten and remove the coolant radiator shutter assembly from radiator.

NOTE: A pry bar may be needed to loosen the sealant between the shutters and the radiator.

3. Remove aerator line fitting if installing a new coolant radiator assembly and reinstall on new radiator assembly.
4. Unfasten and remove coolant radiator to air cooler attachment brackets, separate and remove assemblies.
5. If new air cooler core is to be installed, unfasten and remove cooler framework.

RADIATOR ASSEMBLY

1. If cooler core has been changed, remount framework, install and tighten fasteners.
2. Reinstall coolant radiator to air cooler attachment brackets and fasteners.
3. Replace drain plug if removed.
4. If new radiator is was used reinstall aerator fitting.
5. Replace as necessary the shroud/shutter-to-radiator seals if damaged or deteriorated.
6. Place shutter assembly on coolant radiator and align the top outer corners tight against the radiator corner brackets.

NOTE: Be sure the top outside corners are tight against, but, not on top of the radiator corner bracket (Figure 37) If the top and bottom center mounting screw holes do not have an access hole in the shroud for a screwdriver, drill a screwdriver hole before placing on the radiator.

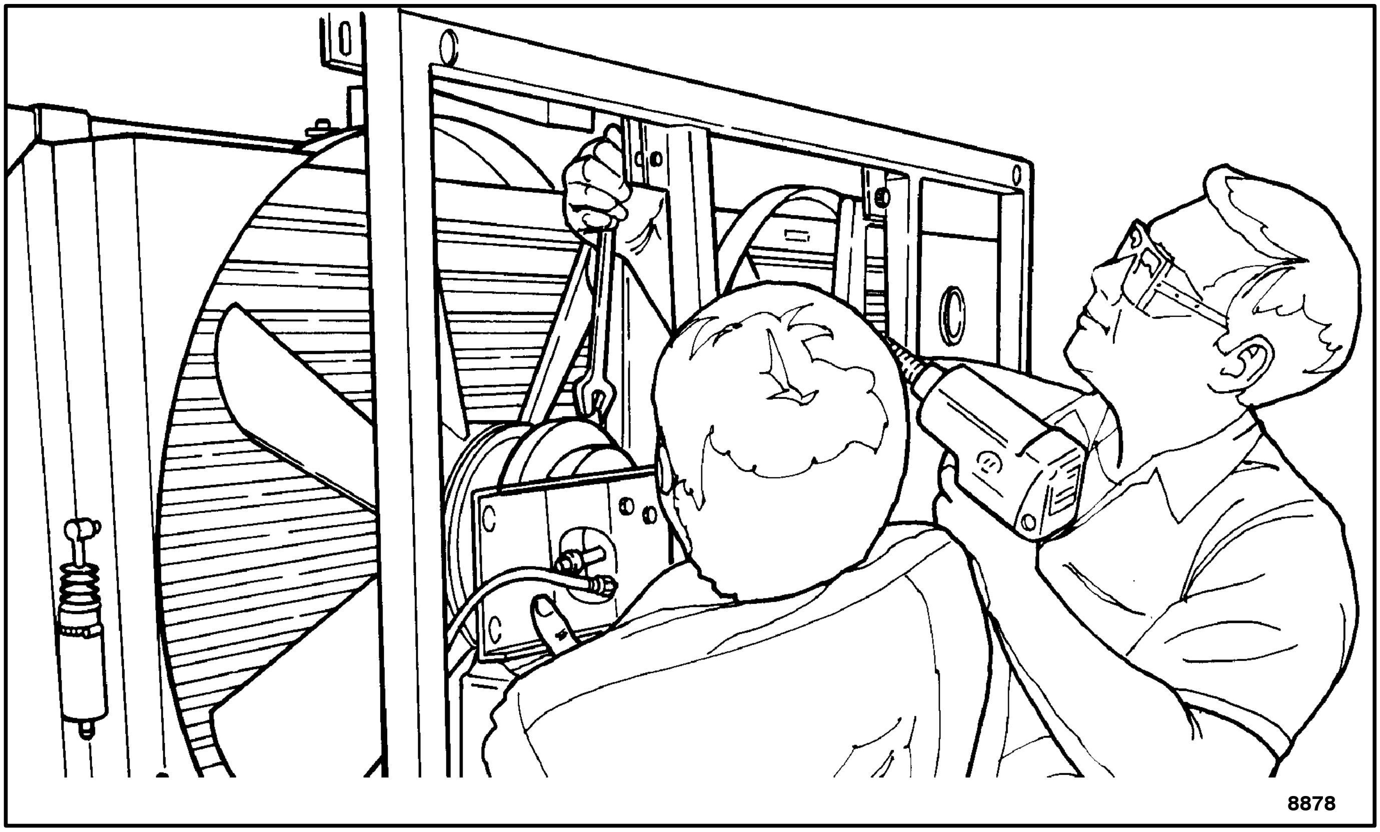


Figure 34. Fan, Clutch and Bracket Removal

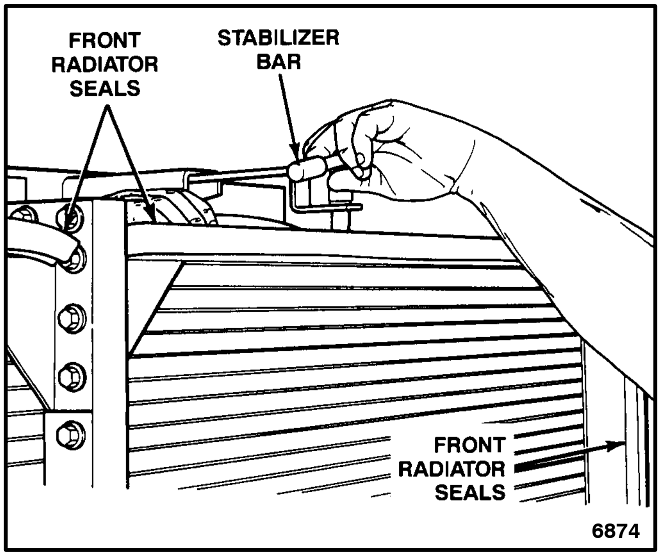


Figure 35. Stabilizer Bar Removal

7. Center punch each mounting hole, if reinstalling on new radiator.

8. Drill mounting holes with a #25 bit, if reinstalling on new radiator.

⚠ CAUTION ⚠

Lay a large flat metal plate on the radiator core (under each hole) to prevent drilling fragments from falling into the core and the bit from hitting the core, if reinstalling on new radiator.

9. With a self-tapping mounting screw and power driver, prethread each hole, drill and tap lubricant will ease pretapping and smoother threads. If reinstalling on new radiator, use metal shield to prevent hitting core.

10. Locate shutter assembly on old radiator and reattach.

11. Mount shrouds onto shutter assembly and cooler frame and reattach.

RADIATOR MODULE ASSEMBLY

1. Set radiator/cooler assembly in module frame.

2. Check alignment of the front lower seal contact angle on frame (Figure), and straighten if out of adjustment.

3. Install one stabilizer bar (loosely).

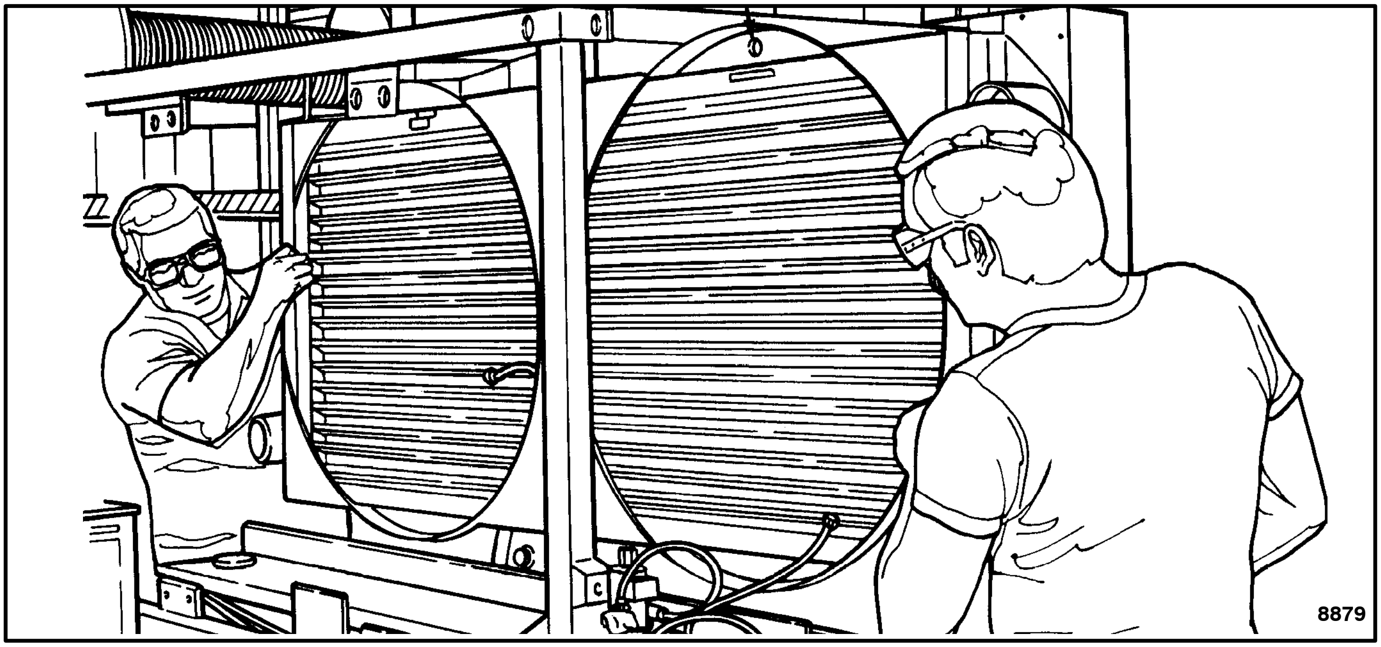


Figure 36. Radiator Assembly Removal

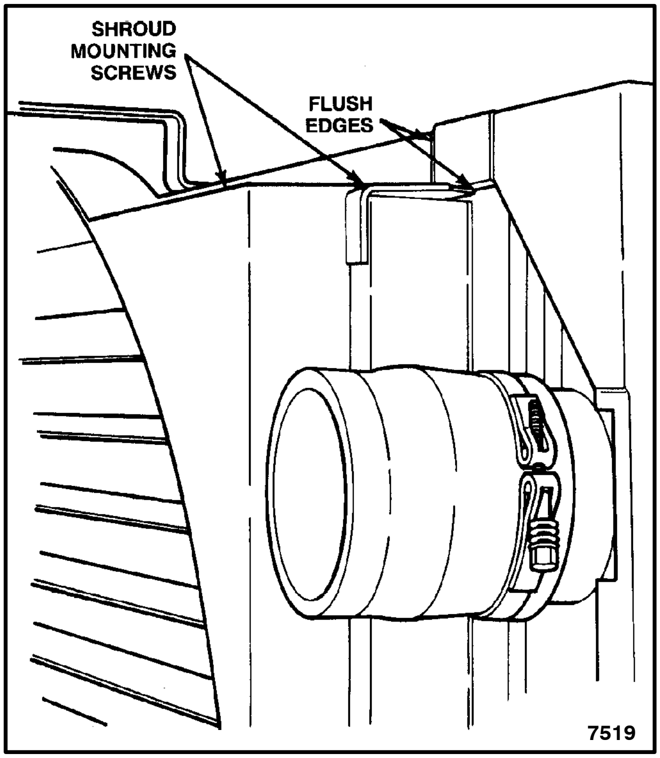

SHROUD MOUNTING SCREWS
FLUSH EDGES
7519

Figure 37. Shutter-To-Radiator Alignment

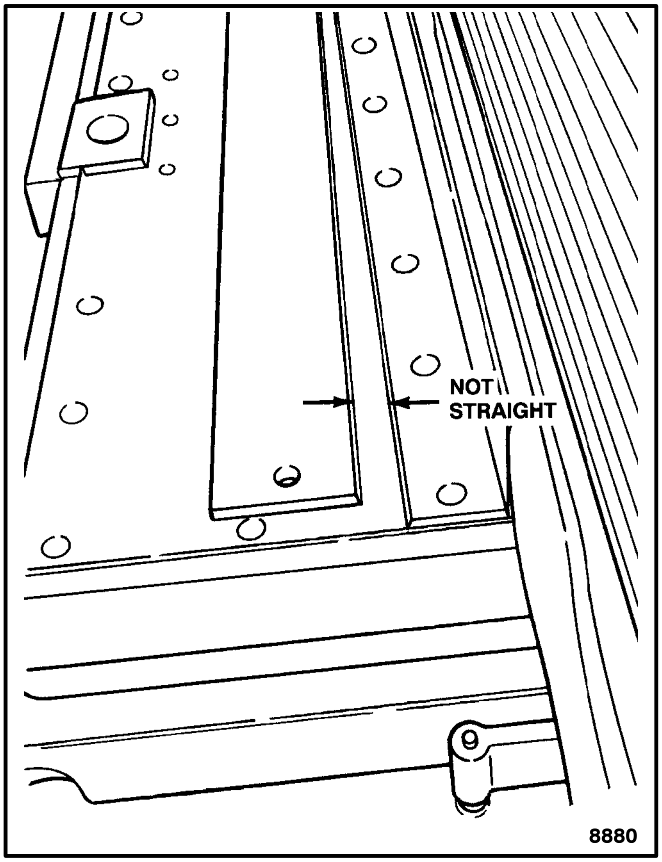

NOT STRAIGHT
8880

Figure 38. Front Seal Angle Alignment

⚠ CAUTION ⚠

Be sure the bolts into the radiator are not too long. The stabilizer bar goes under the bottom of the bracket on the module frame.

4. Raise the module to align radiator/cooler assembly.

5. Align bottom radiator/cooler mounts and install fasteners.

CAUTION

Do not overtighten the radiator mounting bolts.

6. Install fan clutch and shutter cylinder air tube mounting clips.

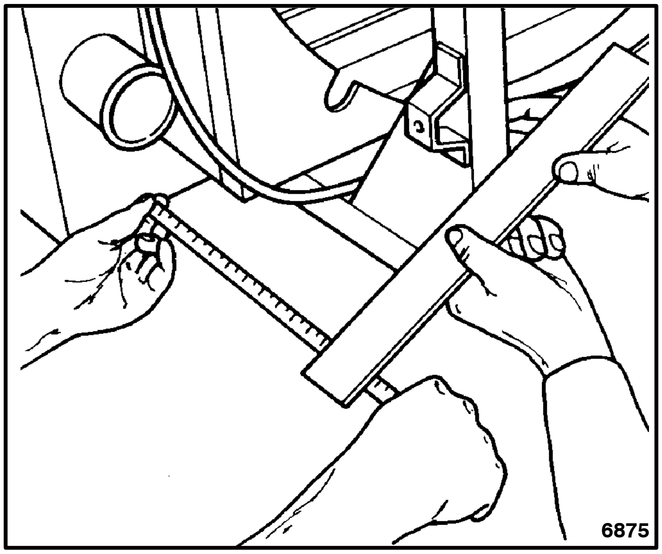


Figure 39. Radiator Plumb to Frame

7. Measure top and bottom radiator-to-frame distances, (both sides), and plumb radiator's vertical (Figure 39). Install second stabilizer bar, and tighten both.

NOTE: Be sure that rubber cushion is inserted between the stabilizer bar and the radiator.

RADIATOR MODULE INSTALLATION

1. Check Radiator sealing panels in cooling compartment for proper sealing contact. Pull panel outward if contact is not being made.

2. Clamp the radiator module to the lift. Align the module with the coach cooling compartment and slide into position.

CAUTION

Be careful that the lift does not damage the Ether cup or other engine parts. Make sure the body skin by the lower mounting brackets is not damaged while installing the module.

3. Place C-clamps on the coach/module mounting brackets to draw the module into the coach.

4. Remove the lift.

5. Remove the spreader board.

6. Install the module mounting bolts (12).

7. Connect the aerator line at the top of coolant radiator.

8. Install the thermostat outlet to radiator inlet tube across the top of the engine.

9. Install charge air cooler's outlet tube section to intake manifold.

10. Install the radiator outlet tube section to water pump inlet tube.

11. Install the charge air cooler's inlet tube section to turbocharger housing outlet.

12. Install the inlet radiator tube to coolant radiator.

NOTE: Check the tube openings for damage, straighten if necessary.

13. Reconnect the surge tank tube if loosened.

NOTE: For proper operation of the controls, the radiator tube must be in a vertical position.

14. Reconnect radiator/cooler inlets and radiator outlet tube mounting brackets, if removed or disconnected for removal.

15. Tighten all inlet and outlet radiator/cooler constant torque clamps.

16. Reattach the solenoid control valve and bracket to the module frame.

17. Connect the solenoid valve's air supply line to shutterstat and electrical harness to switch.

18. Install fan clutch assemblies onto their mounting brackets.

19. Attach the mount brackets complete with clutch assemblies, and center in their shrouds.

NOTE: Before mounting the air cooler's fan clutch assembly to module, install fan-to-fan and engine-to-fan drive belts over fan blades.

20. Reconnect fan clutch and shutter cylinder air lines.

21. Install fan-to-fan drive belt tension device and idler pulley.

22. Install engine-to-fan drive belt tension device and idler pulley.

NOTE: Check the fan blade to shroud clearances.

23. Set the drive belt tensions per specifications using tensioner tools (Figure 40).

24. Connect air tubes of the control system.

25. Connect the supply air line from filter.

26. Install the louvered panels over the cooling compartment openings.

27. Install the trim panel across top of radiator door opening.

28. Install the trim molding above radiator door.

29. Install radiator door, and attach hinges and air springs.

30. Install engine compartment doors and prop rods.

31. Reconnect license plate lamp and radiator door stop lamp wiring.

32. Fill cooling system (See appropriate filling procedure).

33. Turn battery switch on.

34. Start engine and check for leaks and proper operation.

SERVICE TOOLS

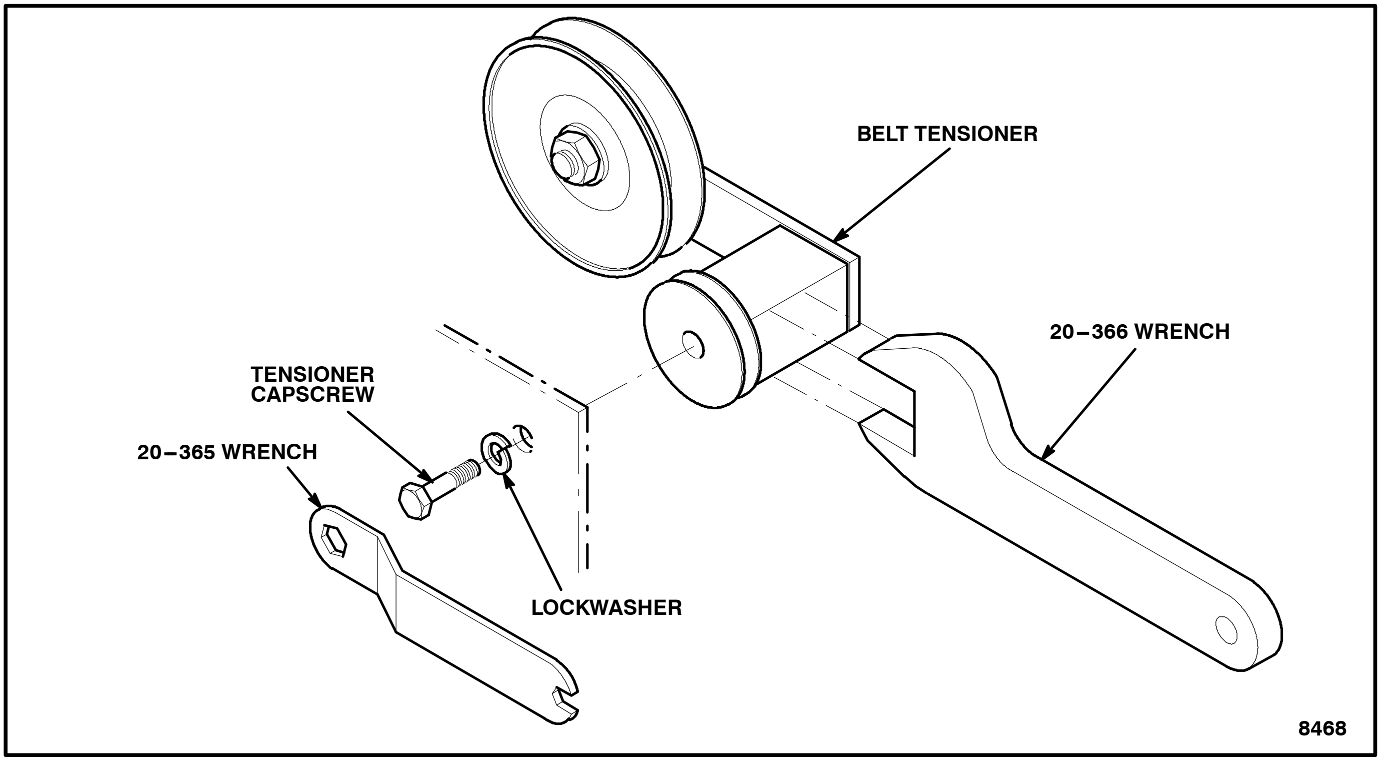

BELT TENSIONER
20–366 WRENCH
TENSIONER CAPSCREW
20–365 WRENCH
LOCKWASHER
8468

Figure 40. Belt Tensioner Service Tools

SPECIFICATIONS

RADIATOR ASSEMBLY

Capacity (Coolant Radiator)	6.0 U.S. Gals. (22.7 liters)
Manufacturer	Young Radiator Co.
Design	Cross-Flow Finned-Tube
Location	(Vertical Mount) Rear of Coach

CLUTCH ASSEMBLY (RADIAL FAN)

Manufacturer	Horton
Design	(Air Actuated) Friction Disc
Part Number (Coolant Radiator)	6L-6-261
Part Number (Air Cooler)	6L-6-263

SHUTTERSTATS

Manufacturer	Kysor
Part Number (190°F Coolant Radiator)	6L-10-76
Temperature Range	187-195°F (86-90°C)

SHUTTERSTAT FILTER ASSEMBLY

Manufacturer	Kysor
Lubrication/Cleaning Fluid	6-10-33
Part Number	6-10-20

INVERSION VALVE (COOLANT RADIATOR FAN CLUTCH)

Manufacture	Bendix
Type	.(Normally Open) TR-3
Part Number	4L-29-3

THREE WAY VALVE (AIR COOLER FAN CLUTCH)

Manufacture	(Skinner Valve Division) Honeywell
Type	.(Normally Open) V55DB1150
Part Number	16B-10-56

SECTION 6A3

RADIATOR & CHARGE-AIR MODULE (SERIES 60, CATERPILLAR & CUMMINS) ENGINE INSTALLATIONS

(EFFECTIVE WITH 102DL3 UNIT 45959)

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 6A3-1
Components 6A3-2
Maintenance 6A3-4
Service Tools 6A3-13
Specifications 6A3-14

GENERAL DESCRIPTION

The charge-air coolant radiator and air cooler module are major components of the engine's cooling and combustion air intake systems. The separate air cooler and coolant radiator assemblies (Figures 1 & 2) are coupled with an air operated clutch fan system, and are mounted directly to the rear upper frame assembly. The heat-dissipating capacity of the radiator assembly along with the fan control system should prevent engine coolant temperatures from rising above the maximum allowable limit as shown in the following specifications. Additionally, the air cooler assembly assures proper air temperatures for optimum engine combustion, and provides for some alternate internal engine component cooling.

Maximum Allowable Coolant Temperatures

Series 60 Installations	210°F (98°C)
Caterpillar Installations	216°F (102°C)
Cummins Installations	212°F (100°C)

NOTE: The coolant's maximum temperature must not be exceeded by any engine operating condition, regardless of altitude, type of coolant used, or cooling system condition. Exceeding this limit can result in power-down safety sequence initiation, engine malfunction and/or serious damage.

As coolant circulates through the engine it gathers heat from the combustion process. The engine thermostat releases coolant, through the engine compartment's coolant piping system, to the radiator module where the heat transfer process takes place. The system uses air drawn over the radiator's finned tubes to achieve this process and reduce the coolant's temperature. The fan pulls air across the radiator through the curbside louvered panel, and radially expels it out the rear radiator door.

The fresh air is compressed and heated by the turbo-charging process. The turbocharger discharges this air into the charge-air air cooler assembly, where air drawn over the cooler's finned tubes reduces the air's temperature, thereby, making it more dense. The heavier cooled air is pushed along by the turbocharger to the intake manifold. The air-cooler's fan pulls air across the exchanger through the left and right side rear louvered panels, and radially expels it out the rear radiator door.

The engine cooling system consists of several components working in conjunction to maintain a safe engine operating temperature. Because the four cycle engines do not produce combustion heat in the amounts required to adequately heat the passenger and driver areas of the coach, an additional Webasto auxiliary heater is installed to augment the coach heating system (Sub-Section 16D). Coolant for the Webasto heater is taken from the engine oil cooler, and afterward routed to the center tunnel piping system.

Coolant is returned to the engine's water pump inlet after completing heating circuit.

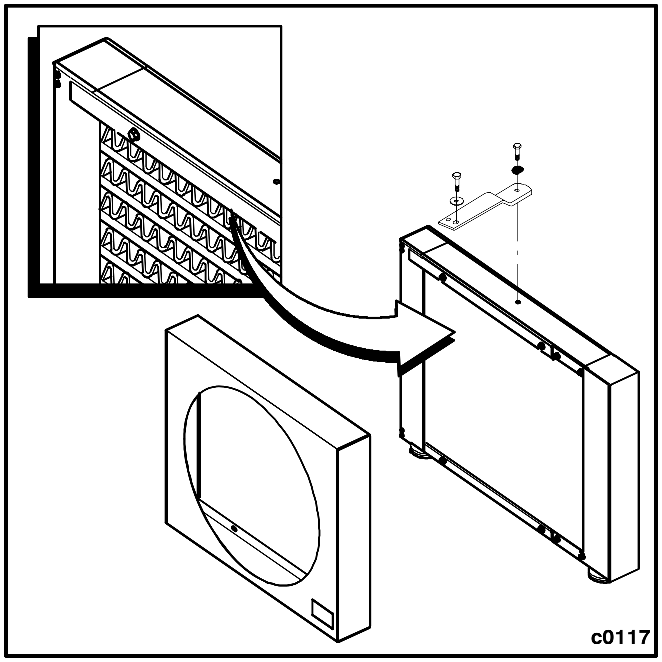


Figure 1. Air Cooler Assembly

COMPONENTS

AIR COOLER ASSEMBLY

The air cooler assembly consists of a core, vertical side air boxes, shroud and mounting framework (Figure 1). The air cooler assembly and coolant radiator are not joined together. The air cooler's core design is finned-tube cross-flow type. Air flow is from left (inlet) to right (outlet), and maintained by the engine's tubrocharger. The radiator is installed in the rear upper frame on special mounts, with air blocking foam seals at outer edges.

RADIATOR ASSEMBLY

The coolant radiator consists of a core, vertical side reservoirs, shroud and mounting framework (Figure 2). The coolant radiator and air cooler assembly are not joined together. The radiator's core design is finned-tube cross-flow type. Coolant flow is from right (inlet) to left (outlet), and maintained by the engine's water pump. The radiator is installed in the rear upper frame on special mounts, with air blocking foam seals at outer edges.

CLUTCH FAN ASSEMBLY

Series 60 Engine Installations

The charge-air coolant radiator and air cooler modules are fitted with twin air-operated coolant and intake air temperature-activated fan clutches for this engine installation.

Cummins & Caterpillar Engine Installations

The charge-air coolant radiator and air cooler modules are fitted with an air-operated coolant fan clutch and a non-air activated hub driven air cooler fan assembly for these engine installations.

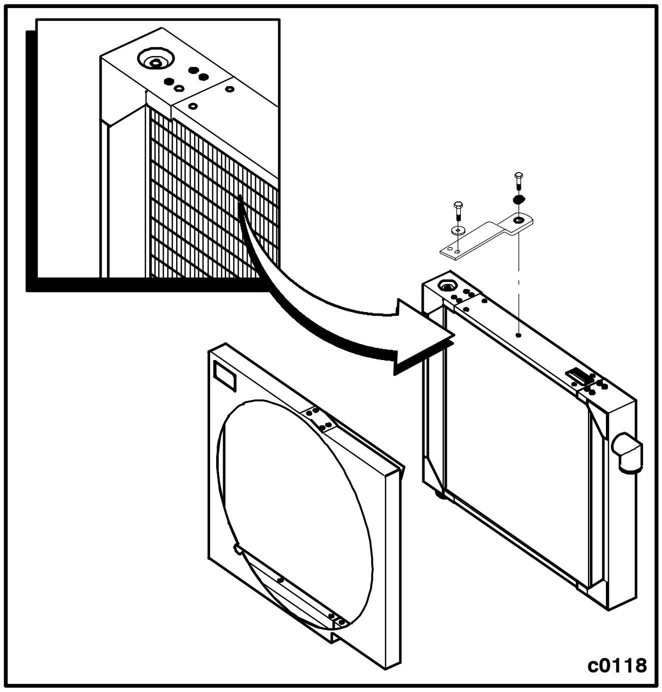


Figure 2. Coolant Radiator Assembly

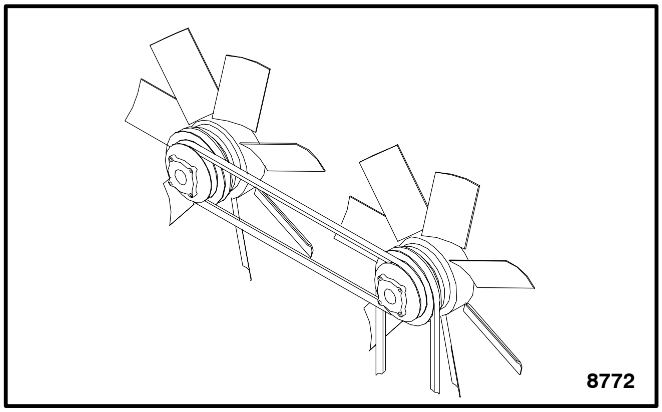


Figure 3. Fan Clutch Mechanism

The clutch mechanism is an air-engaged piston-to-friction plate design. The coolant radiator and air cooler's fan clutch engage by way of the engines ECM which sends an electrical impulse to the solenoid operated air valve when coolant temperature rises to operation temperature. Non-air actuated hub driven fan assemblies remains engaged throughout engine operation (Figure 3).

The coolant radiator mounts a thirty-inch diameter seven-bladed reinforced nylon fan, while the air cooler has a twenty six-inch diameter fan. At engine operating temperature the coolant radiator's fan clutch control system routes air to that fan as required. The air cooler's fan clutch control system allows for a cyclical operation dependent on inlet manifold air temperatures. Each control system maximizes the fan's ability to draw cool air across the exchanger assemblies as needed, while using the minimum amount of horsepower. The automatic function of the coolant radiator fan may be tested or by-passed by activating the test switch at module's lower right corner.

The coolant radiator fan is driven by a single belt from the engine crankshaft pulley. The air cooler fan is single belt driven by the coolant radiator's fan clutch pulley. The fan-to-fan belt drive incorporates a tensioning device and pulley assembly attached to the fan drive's channel frame mounting assembly. The engine crankshaft drive incorporates a tensioning device and pulley assembly attached to the rear upper frame crossmember.

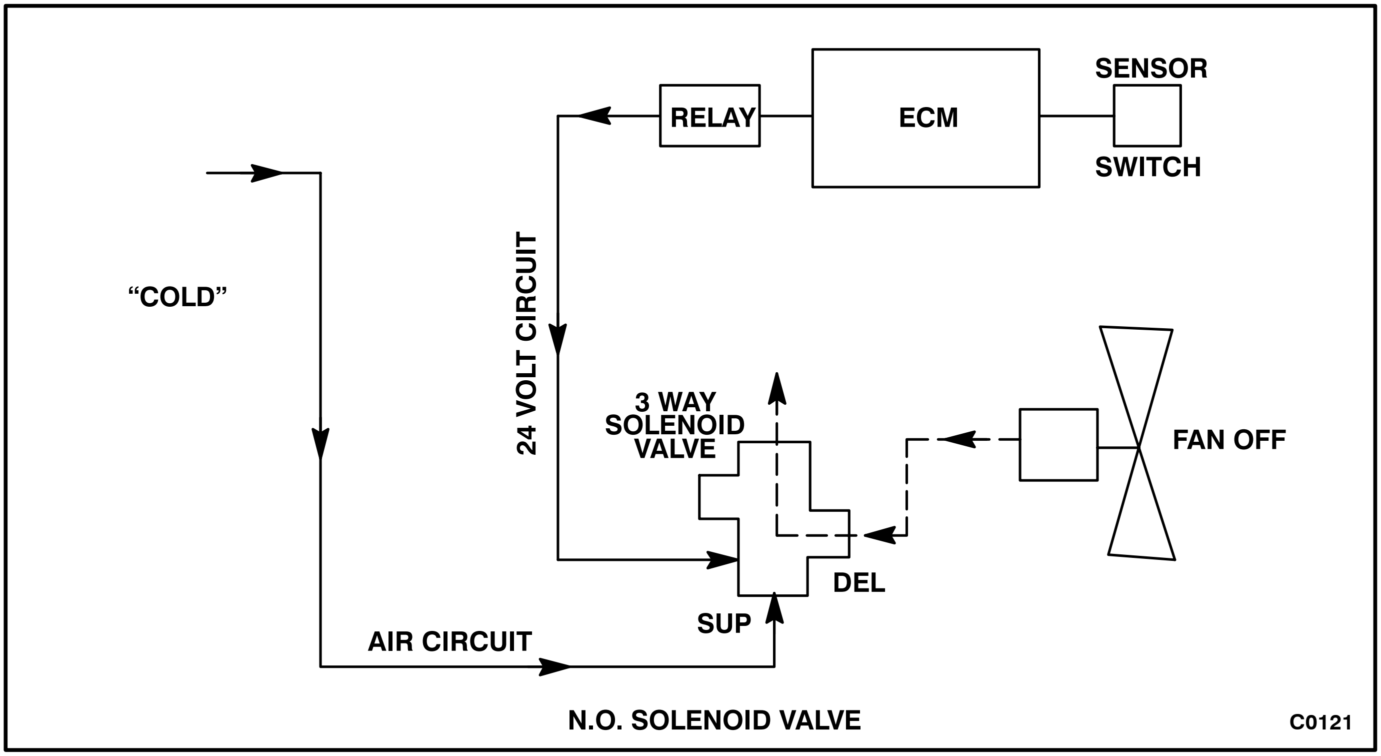


Figure 4. Air Flow Cold Radiator (Caterpillar and Cummins)

AIR CONTROLS

The air control system for the coolant radiator's fan clutch assembly automatically reacts to temperature changes within the engine through monitoring by the engine's electronic control module ECM and the coolant temperature sensor CTS. The control system for the air cooler's fan clutch, (Series 60 installations only), automatically reacts to temperature changes within the intake manifold via the ECM and the ATS, allowing for either fan induced or natural draft cooling. Additionally, the control system features a manually operated electrical fan clutch test switch. All control system air is supplied to the solenoid valve(s) through the shutterstat air filter assembly located below the charge-air coolant radiator and air cooler modules. Electrical ground for the solenoid valve is supplied through the ECM (Series 60). Electrical ground for the solenoid valve is supplied through a relay in the rear junction box (Caterpillar and Cummins).

Series 60 Engine Installations

The coolant radiator and air cooler's control system components consist of the DDEC III electronic control module ECM, an air temperature sensor ATS, a coolant temperature sensor CTS, two (2) three-way solenoid operated air valves and an electrical test switch.

Cummins & Caterpillar Engine Installations

The coolant radiator's control system components consist of the Cummins CELECT™ or Caterpillar electronic control module ECM, an air temperature sensor ATS, a coolant temperature sensor CTS, one (1) three-way solenoid operated air valve and an electrical test switch.

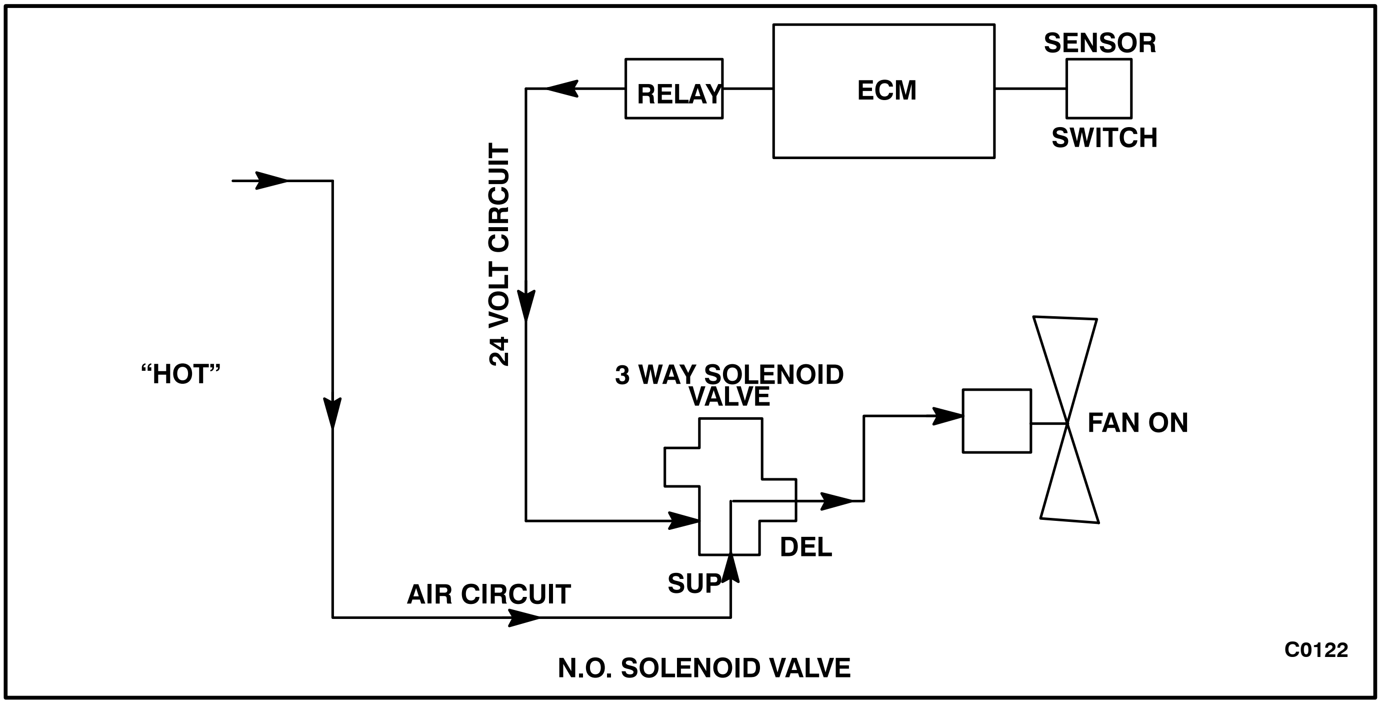

SENSOR
RELAY
ECM
SWITCH
24 VOLT CIRCUIT
"HOT"
3 WAY SOLENOID VALVE
FAN ON
DEL
SUP
AIR CIRCUIT
C0122
N.O. SOLENOID VALVE

Figure 5. Air Flow Hot Radiator (Caterpillar and Cummins)

The solenoid valve(s) and switch are mount to the lower right hand side of the coolant radiator. The ATS and CTS are mounted in the engine's intake air manifolds and thermostat housings respectively.

Operation

At engine start the ATS and CTS sensor switch(es) are closed awaiting increased temperatures. The normally open solenoid valve(s) are closed, due to the completed circuit, and all air is exhausted from the fan clutch(es) (Figure 4).

As engine coolant and intake air reach operating temperature the ATS and CTS sensors open. The normally open solenoid valve(s), which were closed now open and let air through to engage fan clutch allowing the fan to begin operation. (Figure 5).

The ATS is not applicable to Caterpillar and Cummins installations. The air control system's design maximizes the module's ability to transfer heat, while using the minimum amount of horsepower.

NOTE: If a low air situation or a complete loss of air pressure exists on the coach at engine startup, the module's air control system may briefly exhibit some fan clutch engagement/disengagement until coach air system fills to operating pressure.

MAINTENANCE

FAN DRIVE BELT ADJUSTMENTS

Proper belt tension must be maintained on the engine-to-fan and fan-to-fan drives (Figure 6). Belts should be tensioned to the deflections shown, when forces shown are applied at mid-spans.

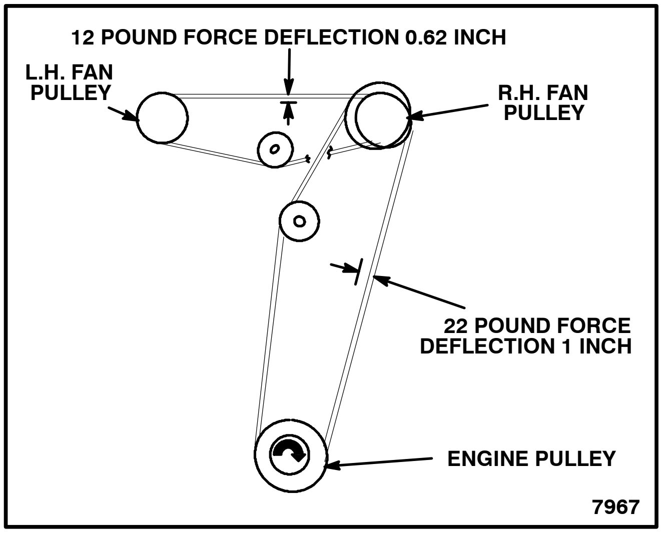

12 POUND FORCE DEFLECTION 0.62 INCH
L.H. FAN PULLEY
R.H. FAN PULLEY
22 POUND FORCE DEFLECTION 1 INCH
ENGINE PULLEY
7967

Figure 6. Drive Belt Tensioning

To adjust tension loosen hex head capscrew mounting tensioner assembly. Apply pressure to the belt by rotating tensioner assembly into the belt using a wrench on the 2 inch square of the tensioner base. When belt is properly tensioned, tighten the mounting bolt while holding the tensioner assembly in place. Mounting bolt torque should be 55-65 ft-lbs (74.6-88.1 N·m).

ENGINE-TO-FAN BELT REMOVAL

1. Loosen belt tensioner assembly.
2. Remove belt from sheave on engine crank pulley.
3. Close shutters on radiator using the switch located on module frame.
4. Slide belt between the fan and closed shutter using the notch located in the lower left-hand corner of the fan shroud to help work belt around fan blade.

INSTALLATION

Install belt by reversing procedure. When installing a new belt check and retension belt after 200 miles of operation and again at 2,000 miles of operation using “BELT ADJUSTMENT” procedure described eariler.

FAN-TO-FAN BELT REMOVAL

1. Loosen the belt tensioner assembly and remove the engine-to-fan belt from the engine drive pulley.
2. Loosen the tensioner on the fan-to-fan drive belt and remove.
3. Remove left-hand fan, clutch and frame assembly (see “RADIATOR MODULE DISASSEMBLY”).
4. Remove belt from right-hand fan assembly using same procedure used to remove engine-to-fan drive belt.

INSTALLATION

1. Reverse procedure to install new fan-to-fan belt.
2. Reinstall fan frame assembly, See “RADIATOR MODULE ASSEMBLY” for proper assembly steps.
3. Tension belt to proper specification and recheck tension after 200 miles and 2000 miles of operation.

CLUTCH FAN ASSEMBLY

The air-actuated clutch mechanism on the Horton Diesltemp® requires some periodic maintenance (Figure 7). Every 25,000 miles (40,225 km) the clutch air chamber should be inspected for air leakage. If leaks are found follow the procedure for “O-ring and Face Seal Replacement”. Additionally, it’s recommended that every 350,000 miles (563,150 km) the procedure for “Major Overhaul” should be performed. Follow all procedures in the order in which they appear.

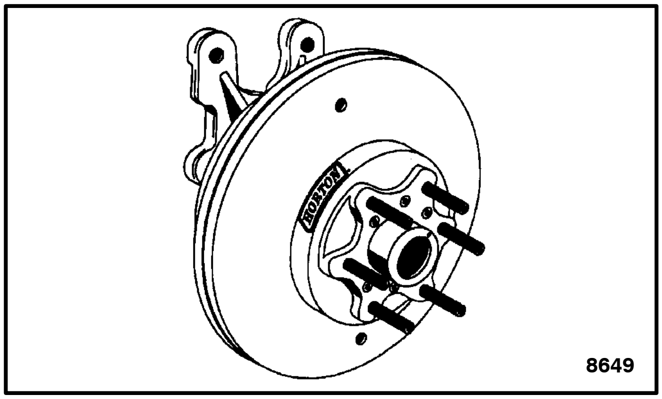


Figure 7. Clutch Mechanism

Clutch Fan Removal

1. Follow procedure for primary or secondary drive belt removals.
2. Unfasten and remove the clutch fan assembly from module frame.
3. Unfasten and remove nylon fan blade from clutch mounting hub.

Clutch Disassembly

1. Clamp fan clutch in vise.
2. Remove socket head fasteners from air chamber (Figure 8).

NOTE: Applying air pressure to clutch aids in removal of air chamber assembly from clutch. Attention must be exercised when using this procedure to prevent air chamber from popping off, resulting in personal injury.

3. Slide air chamber assembly off piston/friction disc.

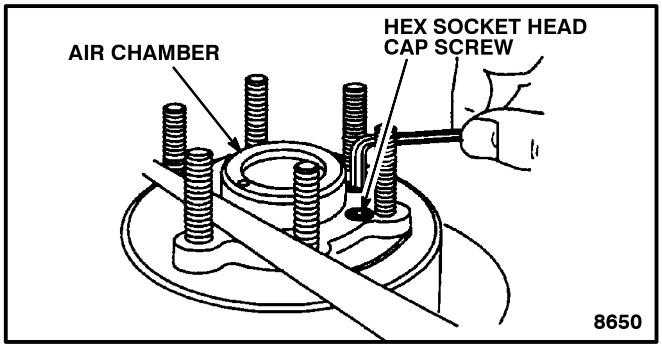


Figure 8. Clutch and Air Chamber Removal

4. Examine air chamber for signs of dirt or foreign matter.

NOTE: Air chamber should be clean and dry. If not, a problem exists in the vehicle air system, and must be corrected before fan clutch is reinstalled. See “Shutterstat Filter” later in this section.

O-ring and Face Seal Replacement

1. Remove O-ring from air chamber and clean O-ring contact surfaces (Figure 9.)

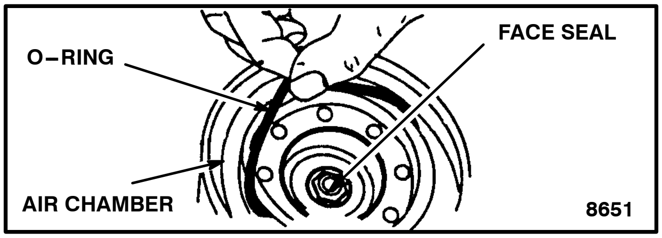


Figure 9. Small O-ring Removal

2. Remove and inspect face seal for signs of wear that may indicate dirt exists in air system.

3. Remove piston/friction disc and clean splines of both the friction disc and hub (Figure 10).

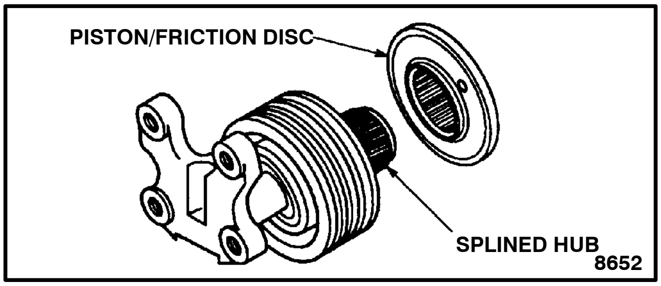


Figure 10. Friction Disc Removal

4. Apply an even coat of spline lubricant to hub (supplied with repair kit).

5. Install piston/friction disc.

6. Replace face seal and tighten to 50 in-lbs (5.7 N·m).

7. Lubricate new air chamber O-ring and O-ring contact surfaces with special O-ring lubricant (supplied with repair kit) and install.

8. Remove O-ring from piston/friction disc and clean O-ring contact surfaces (Figure 11).

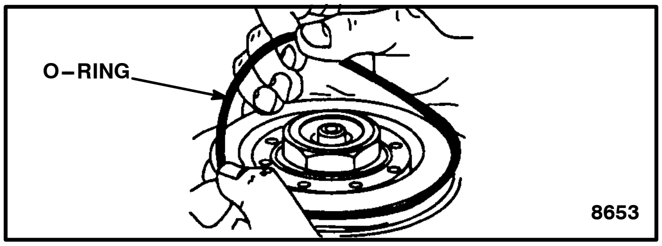


Figure 11. Large O-ring Removal

9. Lubricate new piston/friction disc O-ring and O-ring contact surfaces with special O-ring lubricant (supplied with repair kit) and install.

NOTE: Entire tube of O-ring lubricant should be used.

Air Cartridge Replacement

1. Remove air cartridge retaining ring from face seal (Figure 12).

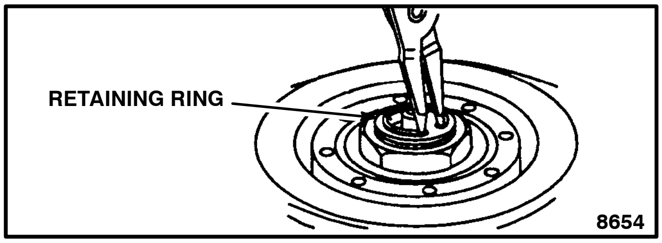


Figure 12. Retainer Ring Removal

2. Remove cartridge assembly, O-ring and end cup (Figure. 13)

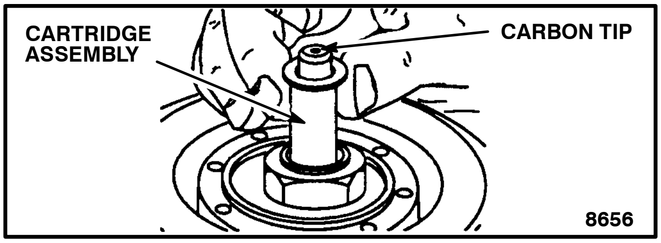


Figure 13. Cartridge Removal

3. Install new end cup (open end down), O-ring and cartridge assembly, and reinstall retaining ring (Figure. 14)

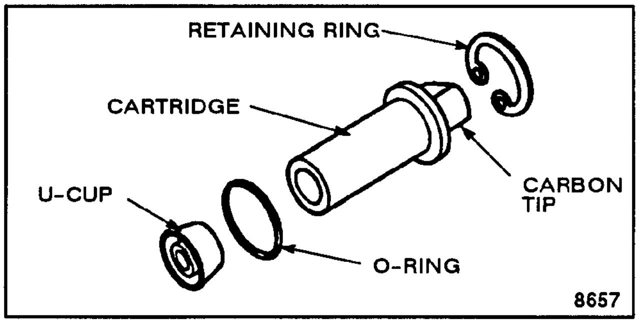


Figure 14. Cartridge Assembly

NOTE: Retaining ring must be fully seated in groove.

4. Clean carbon tip of cartridge assembly and face seal with clean dry cloth.

NOTE: A clean carbon tip and face seal is important for extended clutch life.

Clutch Assembly

1. Install air chamber onto piston/friction disc

NOTE: All clutch components must be cleaned and free of all rust and foreign material prior to reassembly.

NOTE: Extreme care should be exercised when replacing the air chamber to avoid damage to O-rings.

2. Install and tighten socket head fasteners to 180 in-lbs (20.3 N·m).

3. Apply 90 to 120 p.s.i. of clean air to clutch to check for proper engagement, and verify that there are no air leaks.

Major Overhaul Dissassembly

1. Follow the procedure for "Clutch Fan Removal" and "Clutch Disassembly".

2. Remove locknut retaining hub to journal (Figure 15).

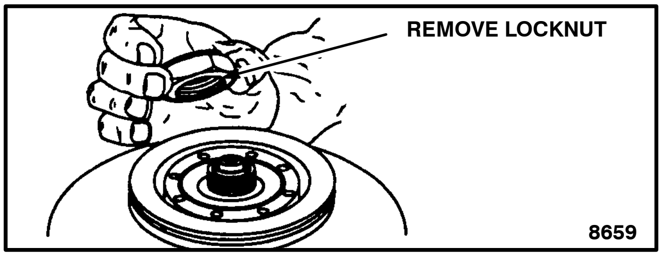

REMOVE LOCKNUT
8659

Figure 15. Locknut Removal

3. Remove spacer, seal and piston/friction disc assembly from splined hub.

. Slide splined hub off journal bracket (Figure 16).

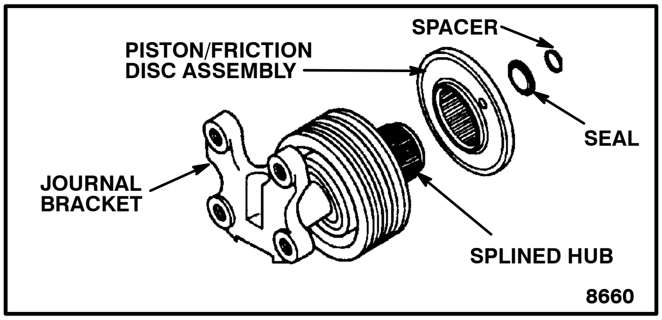

SPACER
PISTON/FRICTION DISC ASSEMBLY
SEAL
JOURNAL BRACKET
SPLINED HUB
8660

Figure 16. Hub Removal

Bearing Replacement

1. Remove journal spacer between hub and sheave (Figure 17).

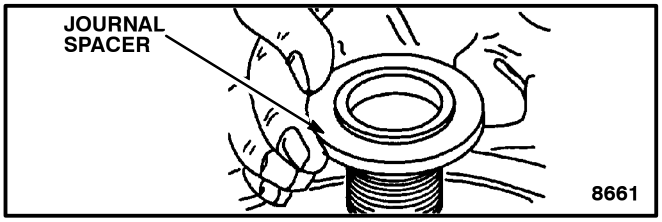

JOURNAL SPACER
8661

Figure 17. Journal Spacer Removal

2. Slide sheave off journal bracket spindle (Figure 18).

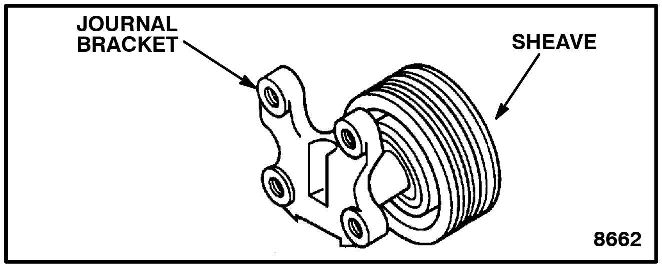

JOURNAL BRACKET
SHEAVE
8662

Figure 18. Sheave Removal

3. Support sleave for bearing removal, and press both bearings out of sheave (Figure 19).

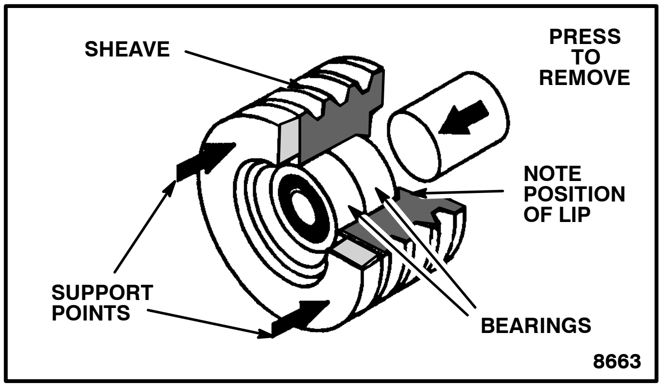

SHEAVE
PRESS TO REMOVE
NOTE POSITION OF LIP
SUPPORT POINTS
BEARINGS
8663

Figure 19. Bearing Removal

NOTE: Some clutch models contain spacers between bearings (Figure 20).

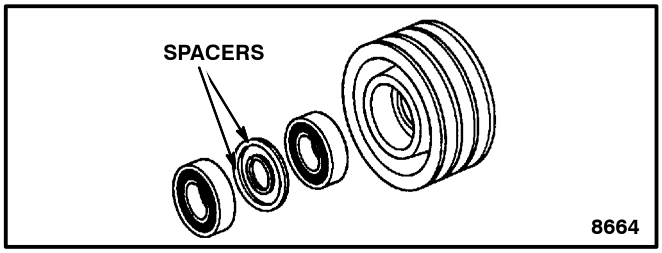

SPACERS
8664

Figure 20. Bearing Spacer Location

4. Position new bearings and press into place (Figure 21).

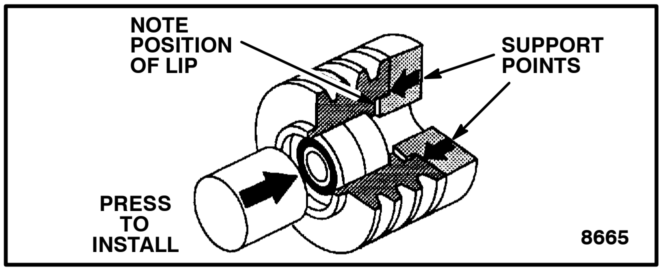

NOTE POSITION OF LIP
SUPPORT POINTS
PRESS TO INSTALL
8665

Figure 21. Bearing Installation

NOTE: All bearings are prelubricated and sealed, Do not remove seals to lubricate.

Friction Facing Replacement

1. Inspect friction facing and replace if worn to 1/16 inch (1.6 mm) thickness, oily, or burnt.

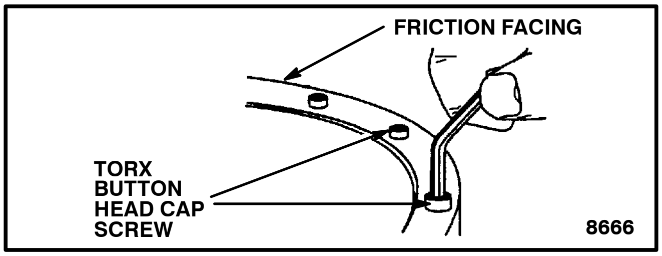


Figure 22. Friction Face Removal

2. Unfasten and remove button head capscrews, and remove friction facing (Figure 22).
3. Install new friction facing and tighten fasteners to 35-40 in-lbs (4.4-4.5 N·m).
4. If required proceed with procedures for “Air Cartridge Replacement” and/or “O-ring and Face Seal Replacement”.

Major Overhaul Assembly

1. Slide sleave onto journal bracket spindle.
2. Install journal spacer.

NOTE: Install journal spacer with lip facing toward front of clutch.

3. Clean and Lubricate hub splines if “O-ring and Face Seal Replacement” procedure was not done.
4. Slide splined hub assembly onto journal bracket spindle.
5. Install seal and spacer onto journal bracket spindle.
6. Replace locknut and tighten to 150 ft-lbs (203 N·m).
7. Slide piston/friction disc assembly onto splined hub
8. If “O-ring and Face Seal Replacement” was done, refer to procedure for “Clutch Assembly.”
9. Replace and tighten socket head fasteners to 180 in-lbs (20.3 N·m).
10. Reverse the procedure for “Clutch Fan Removal”, and install fan drive belts.

AIR CONTROLS

Most of the air control system components require little maintenance, and some components are so designed as to be unrepairable. Items such as plastic tubing, fittings, and electrical switches should be considered throw-away items once they are found to be unfit for service. Some parts of the ECM’s internals that control fan operation can be repaired and/or replaced. A component that does demand some periodic service and/or maintenance is the Skinner solenoid valve (Figure 23).

At intervals of 3,000 miles (4,800 km), one ounce (28 ml) of Kysor Air Filter Fluid (PN 6-10-33) should be added to the filter. Remove the plug on the top of the filter body, add fluid and replace the plug. At intervals of 10,000 miles (16,000 km) the air filter should be disassembled and the felts cleaned with commercial solvent or replaced (Figure 24). When reassembling the filter use new gaskets.

Part of the weekly maintenance procedure should be to drain the filter by opening the draincock at the bottom of the filter body while the filter is under pressure. During cold weather operation, the filter should be drained daily.

Every 100,000 miles (160,900 km) or each 3600 operating hours the solenoid valve should be disassembled, cleaned and inspected. The plunger, spring, piston and seals should be checked and replaced if necessary. Follow the disassembly/assembly procedures in order.

Solenoid Valve Disassembly

1. Turn battery disconnect switch off.
2. Disconnect electrical harness from valve terminals.
3. Bleed off air pressure at valve, and disconnect supply and application air lines.
4. Unfasten and remove valve from module assembly.
5. Remove the sleeve adapter, adapter seal, housing nut, nameplate and housing.

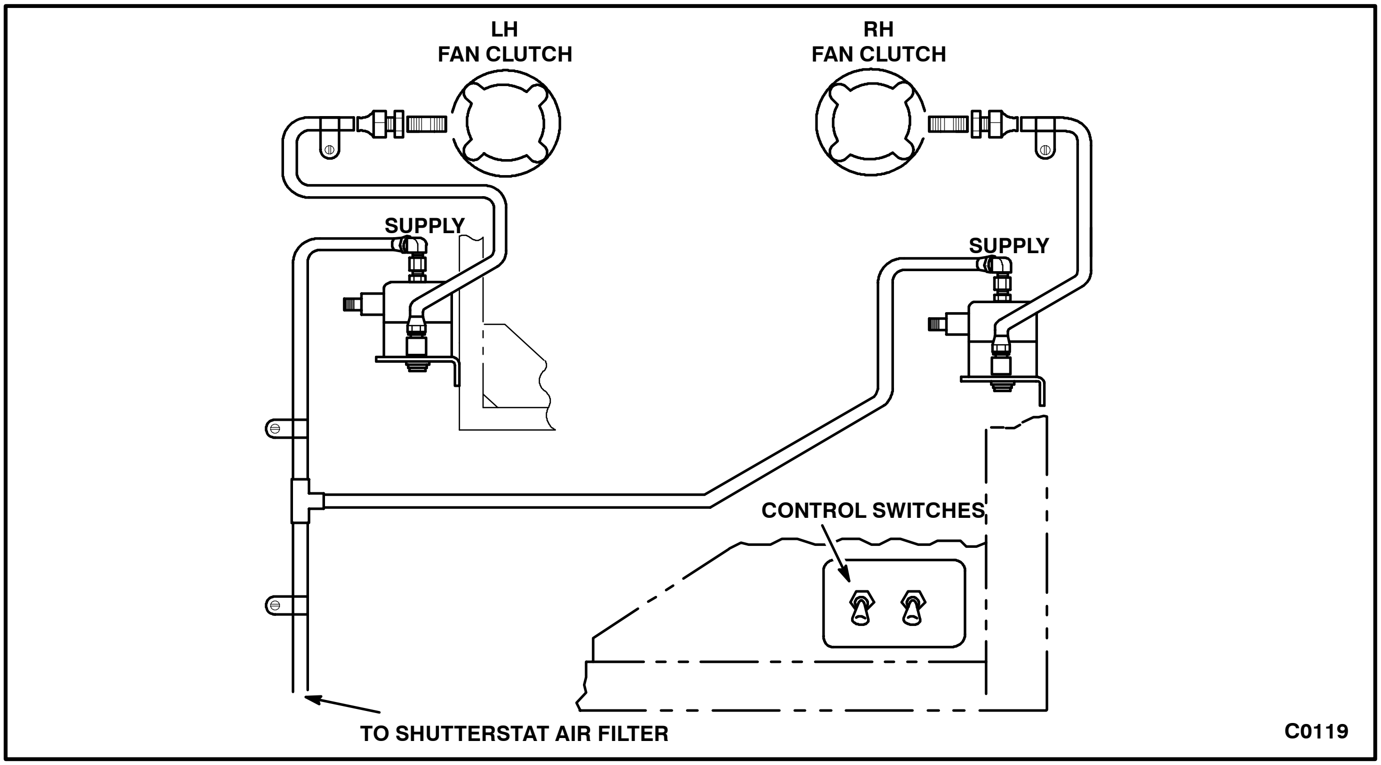

LH
FAN CLUTCH
RH
FAN CLUTCH
SUPPLY
SUPPLY
CONTROL SWITCHES
TO SHUTTERSTAT AIR FILTER
C0119

Figure 23. Control System Components

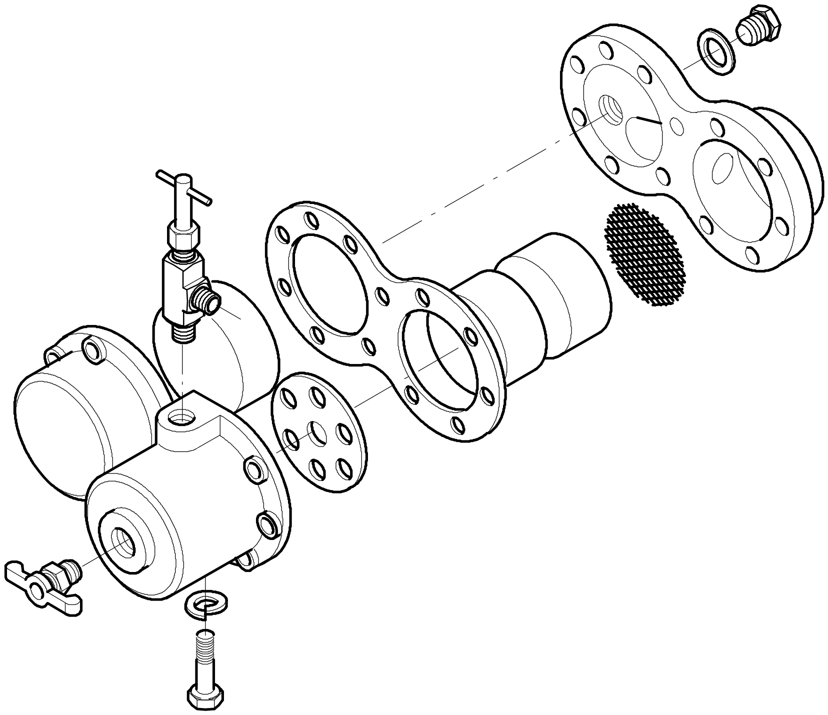


Figure 24. Shutterstat Filter

6. Remove coil assembly from housing if necessary.

7. With special skinner wrench nut, remove sleeve from body

⚠ CAUTION ⚠

Never use a wrench on the sleeve itself.

8. Remove spring, plunger and flanged seal from body

NOTE: Wash plunger assembly, seals and O-rings in mild soap and water solution only.

9. Apply mineral oil to the flanged seal, and reinstall into valve body.

10. Install plunger and spring in sleeve, and tighten sleeve into body with wrench nut to 135 in-lbs (15.4 N·m).

11. Install coil into housing, and assembly housing components in reverse order tightening nut to 35 in-lbs (4.1 N·m).

12. Reinstall onto module assembly.

13. Connect air lines and electrical harness.

14. Turn battery switch on, start engine, and test valve's operation.

RADIATOR ASSEMBLY

It is essential that the radiator cores be kept free from corrosion and debris, and that regular maintenance be performed in conjunction with the other components of the cooling system. See sub-section 6C for further details.

As there are no moving parts on the radiator assembly, no set interval for service, aside from that specified for coolant is necessary. However, inspection of the air seals, and fasteners of attaching components should be made at the coolant inspection or test intervals.

Removal

1. Turn battery switch off, and set park brake.

2. Drain cooling system (see draining procedure in sub-section 6B).

3. Unfasten and remove the rear curbside louvered panel (Figure 25).

NOTE: Removal of this panel is recommended. Two people may be necessary to remove this panel and other components in following steps.

4. Loosen and remove engine-to-fan, and fan-to-fan drive belts from their idler pulleys and clutch hubs.

5. Unfasten and remove any inlet/outlet coolant piping hanger brackets preventing radiator removal.

6. Disconnect and remove coolant radiator outlet tube assembly from radiator outlet.

7. Disconnect and remove coolant radiator inlet tube assembly from radiator inlet. Loosen clamp at top of inlet radiator tube, pull free, twist tube 180 degrees to right, pull up, swing top down, to right and remove (Figure 26).

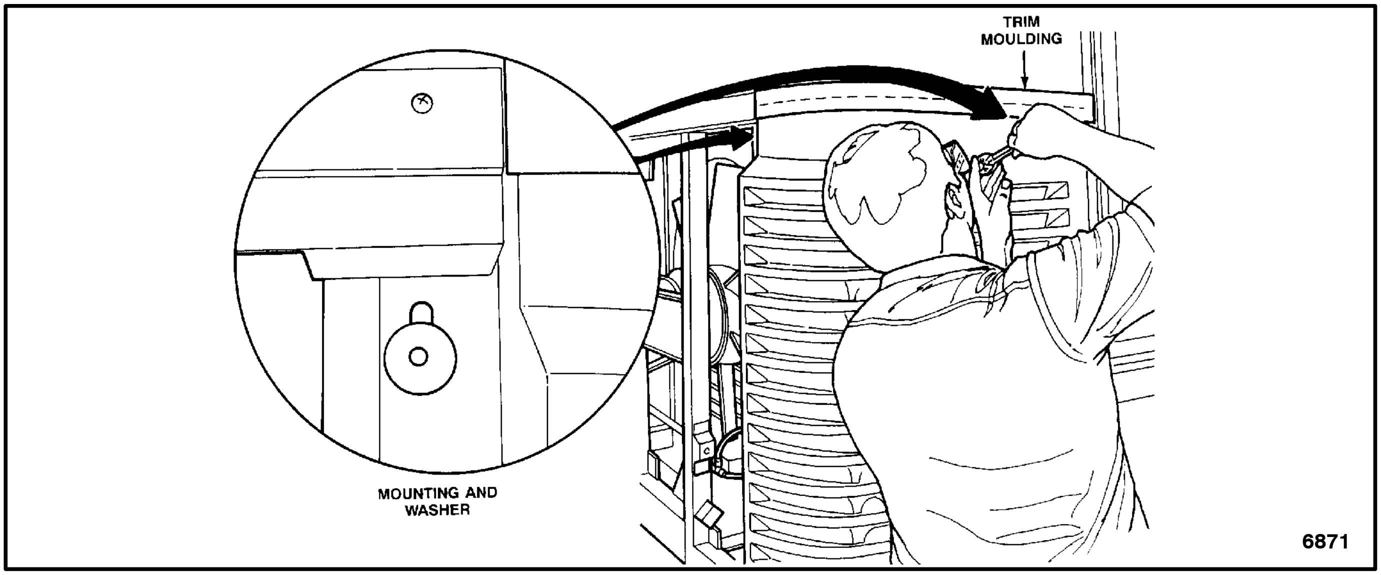


Figure 25. Louvered Panel Removal

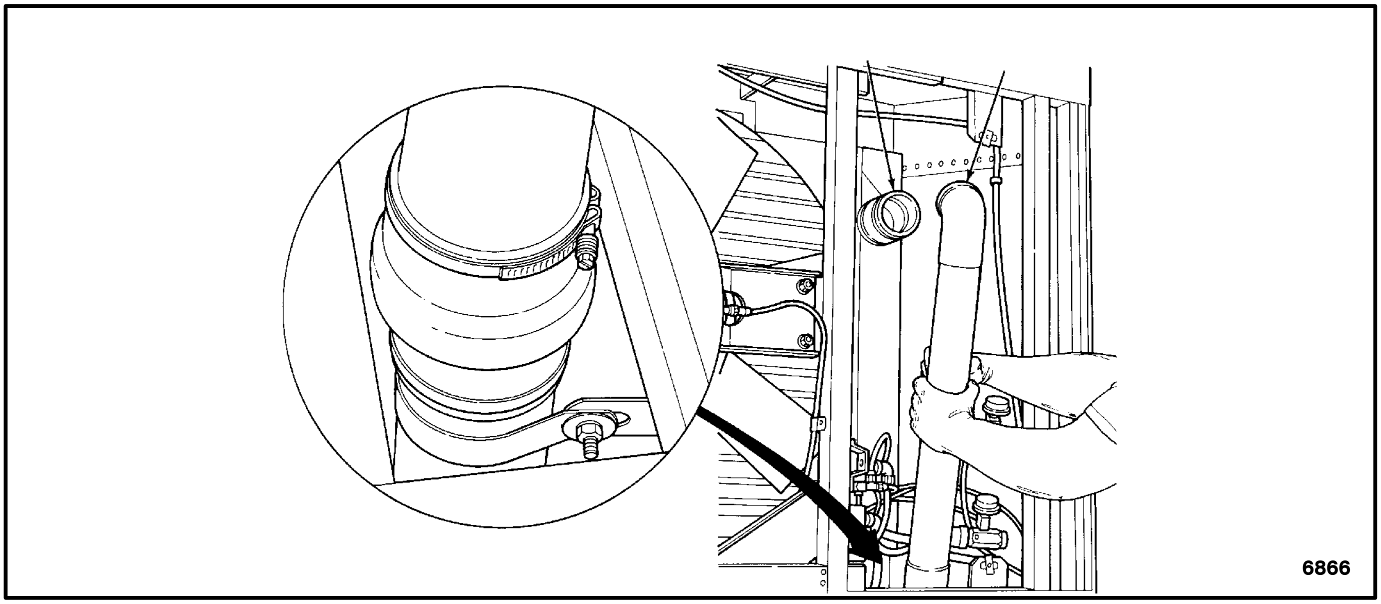


Figure 26. Inlet Tube Removal

8. Loosen the air line on top of the shutterstat air filter and let any air pressure bleed off.

⚠ WARNING ⚠

When disconnecting the air supply line, wear proper eye protection.

9. Disconnect clutch fan(s) air supply line(s) and mount clips.

10. Unfasten and remove bolting securing the radiator's clutch fan channel support, and carefully pull out and off of rear frame taking care not to damage fan blades.

11. Unfasten and remove the crankshaft drive belt tensioner and bracket.

12. Remove aerator line from top of coolant radiator, and stow out of way.

13. Unfasten and remove the upper radiator mounting from upper stabilizer bar.

14. Unfasten and remove the two (2) lower radiator mounting bolts from rear frame support channel.

NOTE: Pry bars may be necessary. Use heel bar driven between the mounting brackets to loosen the radiator.

15. Gently pull left side of radiator out and away from air cooler. Slide radiator toward middle of frame opening and remove (Figure 27).

⚠ CAUTION ⚠

DO NOT drag the radiator's bottom while removing from coach.

CHARGE-AIR COOLER ASSEMBLY

As there are no moving parts on the air cooler assembly, no set interval for service is required, however, inspection of the inlet/outlets, air seals, and fasteners of attaching components should be made periodically.

Removal

1. Turn battery switch off, and set park brake.

2. Loosen and remove engine-to-fan, and fan-to-fan drive belts from their idler pulleys and clutch hubs.

3. Unfasten and remove any inlet/outlet coolant piping hanger brackets preventing radiator removal.

4. Disconnect and remove the air cooler's inlet tube.

5. Disconnect and remove the air cooler's outlet tube.

6. Loosen the air line on top of the shutterstat air filter and let any air pressure bleed off.

⚠ WARNING ⚠

When disconnecting the air supply line, wear proper eye protection.

7. Disconnect clutch fan(s) air supply line(s) and mount clips (Series 60 installations only).

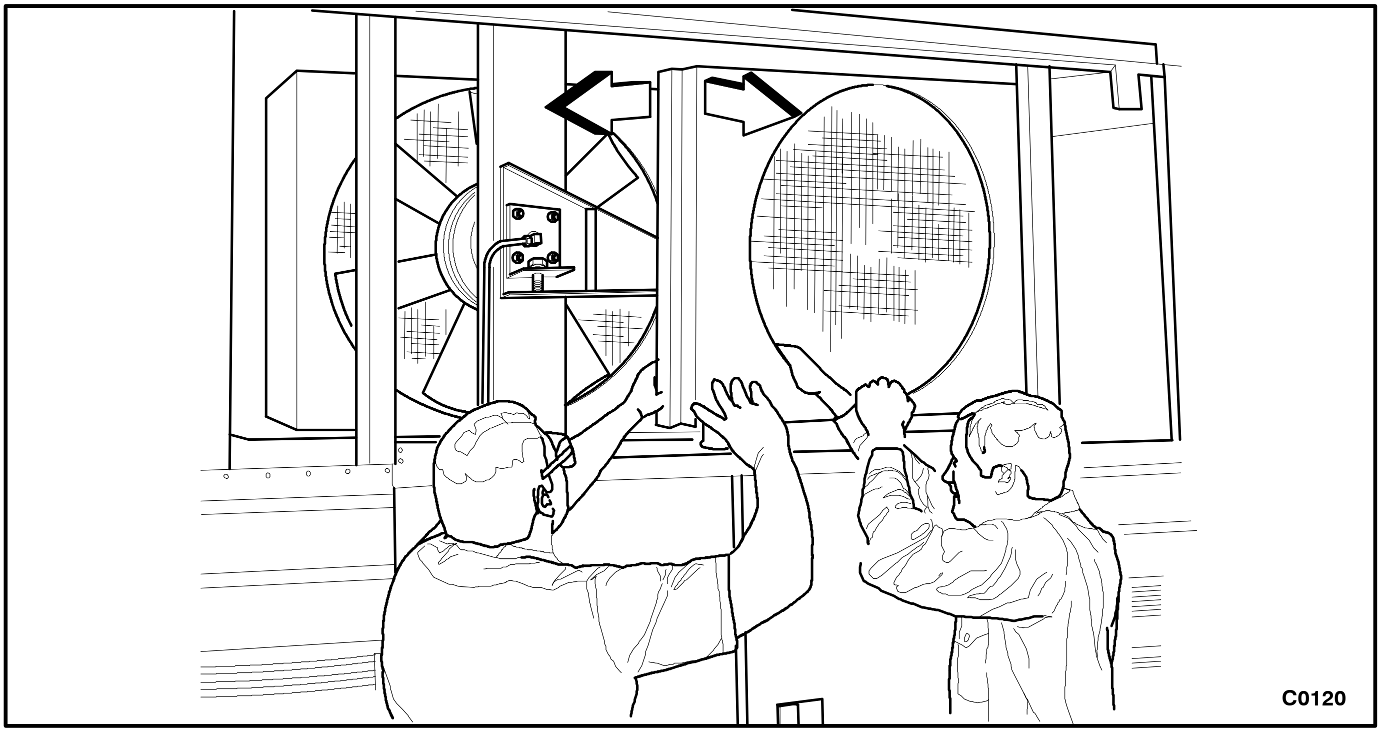


Figure 27. Radiator Removal

8. Unfasten and remove bolting securing the air cooler's clutch fan or hub driven fan channel support, and carefully pull out and off of rear frame taking care not to damage fan blades.

9. Unfasten and remove the crankshaft drive belt tensioner and bracket.

10. Unfasten surge tank hose mount clips from the air cooler.

11. Unfasten and remove the two (2) lower air cooler mounting bolts from rear frame support channel.

12. Unfasten and remove the upper air cooler mounting from upper stabilizer bar.

Radiator/Air Cooler Disassembly

1. With radiator or air cooler on a flat surface, unfasten and remove the shroud.

2. Clean seal material from shrouds and/or exchangers if damaged or deteriorated.

NOTE: Check inlet/outlet openings for damage, and straighten if necessary.

Radiator/Air Cooler Assembly

1. Install new seal material onto shrouds and/or exchangers if damaged or deteriorated.

2. Position shroud onto radiator or air cooler and align holes to install fasteners.

Radiator/Air Cooler Installation

1. Reverse their respective removal procedure's steps to install the radiator or air cooler assembly.

2. Torque the upper/lower mount fasteners to 40 ft-lbs (55 N·m).

NOTE: Check the fan blade to shroud clearances, and adjust if necessary.

3. Retension all belts per belt tension procedure as described previously using tension tools (Figure 28).

4. Refill radiator, turn battery switch on and start engine to check for leaks and proper operation.

SERVICE TOOLS

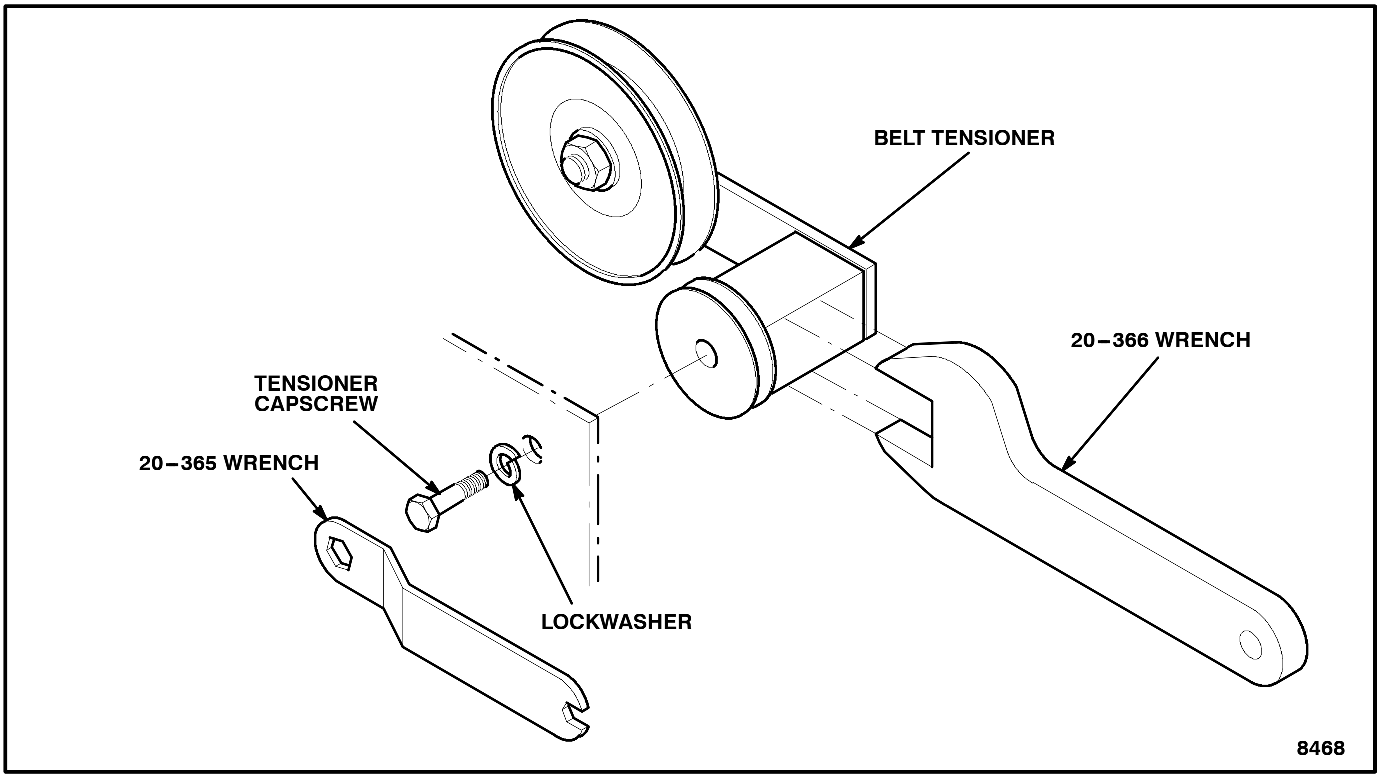

BELT TENSIONER
20−366 WRENCH
TENSIONER CAPSCREW
20−365 WRENCH
LOCKWASHER
8468

Figure 28. Belt Tensioner Service Tools

SPECIFICATIONS

RADIATOR ASSEMBLY

Part Number (Series 60, Caterpillar & Cummins Installations)	6L-1-193
Part Number (470 HP Series 60)	6L-1-220
Capacity (Coolant)	Approximate 6.0 U.S. Gals. (22.7 liters)
Manufacturer	Young Radiator Co.
Design	Cross-Flow Finned-Tube
Location	(Vertical Mount) Rear RH Coach

AIR COOLER ASSEMBLY

Part Number (Series 60, Caterpillar & Cummins Installations)	6L-1-195
Part Number (325 HP Caterpillar Installations)	6L-1-209
Capacity (CFM)	Approximate
Manufacturer	Young Radiator Co.
Design	Cross-Flow Finned-Tube
Location	(Vertical Mount) Rear LH Coach

FAN & CLUTCH ASSEMBLY (RADIAL FAN)

Part Number (Coolant Radiator) (Series 60 & Cummins Installations)	6L-6-267
Part Number (Coolant Radiator) (470 HP Series 60 Installations)	6L-6-392
Part Number (Coolant Radiator) (350 HP Caterpillar Installations)	6L-6-381
Part Number (Coolant Radiator) (325 HP Caterpillar Installations)	6L-6-385
Part Number (Air Cooler) (Series 60)	6L-6-266
Manufacturer	Horton
Design	(Air Actuated) Friction Disc

FAN & HUB ASSEMBLY (RADIAL FAN)

Part Number (Air Cooler) (350 HP Caterpillar Installation)	6L-6-380
Part Number (Air Cooler) (325 HP Caterpillar Installation)	6L-6-384
Part Number (Air Cooler) (Cummins Installation)	6L-6-394
Manufacturer	Horton
Design	Solid Hub

SHUTTERSTAT FILTER ASSEMBLY

Manufacturer	Kysor
Lubrication/Cleaning Fluid	6-10-33
Part Number	6-10-20

THREE WAY VALVE (FAN CLUTCH)

Manufacture	(Skinner Valve Division) Honeywell
Type	.(Normally Open) V55DB1150
Part Number	16B-10-56

SECTION 6B

COOLING SYSTEM COMPONENTS (TYPICAL)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	6B-1
Components	6B-1
Operation	6B-3
Maintenance	6B-4
Specifications	6B-9
Service Tools	6B-10

GENERAL DESCRIPTION

This chapter addresses all other components in the cooling system that work in conjunction with the radiator module assemblies in dissipating heat generated by the engines during operation. These components and their functions are similar no matter the engine or radiator module with which they are used. Some slight variances may exist, such as the thermostat temperature rating, quantity and location, or that a water pump or oil cooler's capacity may be larger, but the basic function remains the same.

These components include the engine's water pump, thermostat and housing assembly, oil cooler engine compartment piping, surge tank and coolant recovery system. Some related components such as coolant filter, hose clamps, and engine compartment remote control box will also be discussed (Figure 1)

COMPONENTS

COOLANT RECOVERY SYSTEM

The coolant recovery system's primary function is to maintain proper coolant level and fill the radiator assembly when empty. The recovery system also limits the loss of overflow coolant during operation at elevated temperatures by accepting coolant from the surge tank mounted above the radiator module.

The recovery system is fitted with a recovery/holding tank with a capacity of six U.S. gallons (22.7 liters). The tank is connected to the cooling system through the recovery pump line, a pressure relief/overflow and fill cap pressure release lines. The recovery/holding tank is located at the right rear of engine compartment, below the A/C compressor mount.

The basic system includes a remote mounted coolant pump actuated through the control box switch, with a telltale control box light that signals function. Low coolant sensors mounted in the surge tank are used to automatically control the pump's function on the optional coolant recovery system. The optional system includes a dash-mounted telltale that pulses to alert driver.

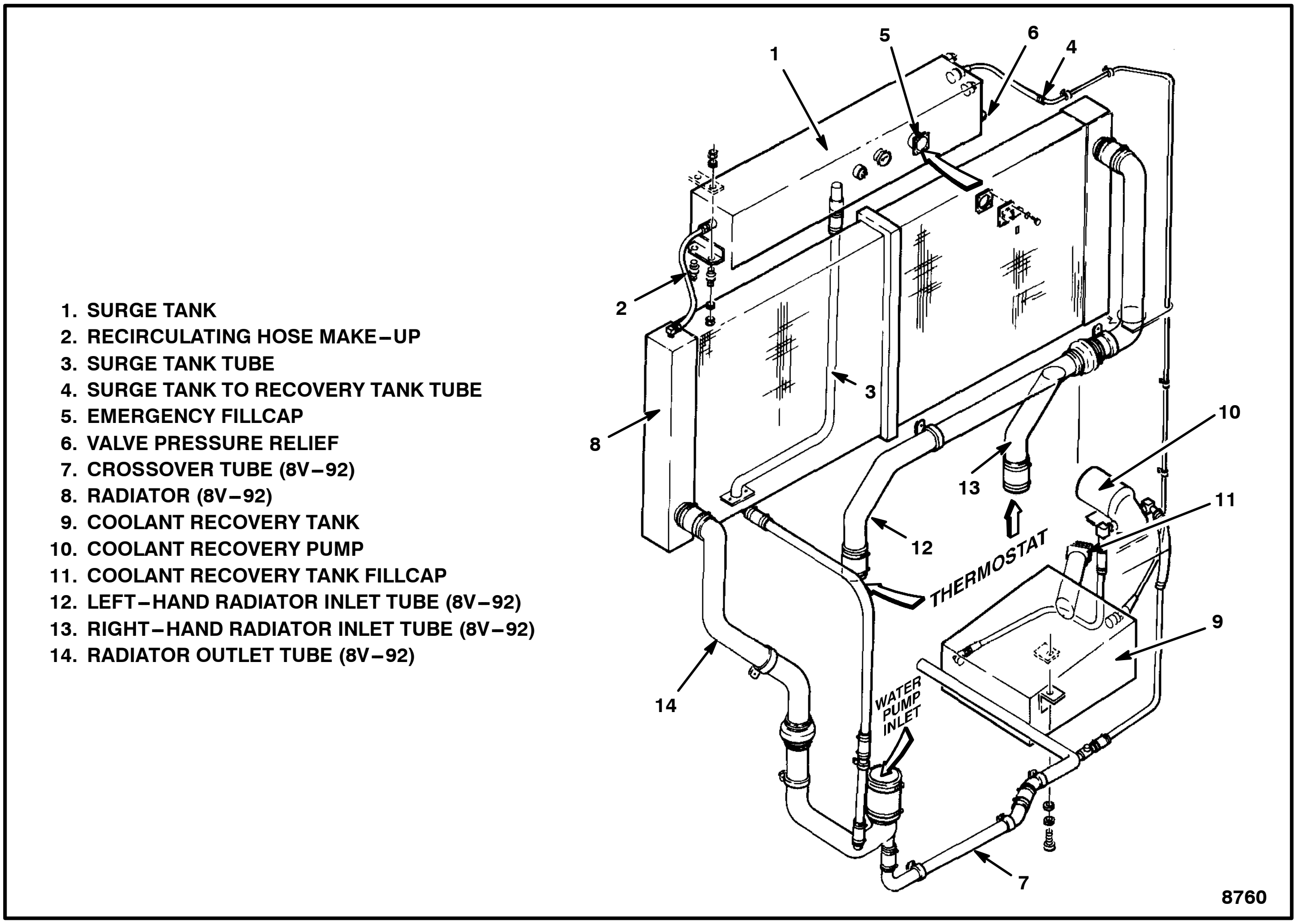
SURGE TANK ASSEMBLY

The surge tank functions as an expansion tank and deareator for the cooling system (Figure 3) Makeup coolant for the system is provided to the water pump from the surge tank. Additionally, the surge tank can be used as a fill point for the system. The basic surge tank is fitted with a sight glass for determining coolant level, a fill nozzle with pressure release, a pressure relief valve and a low-coolant sensor for warning driver.

The optional surge tank, used with the automatic coolant recovery systems, is fitted with two additional sensors on each end of tank to sense coolant level.

ENGINE WATER PUMP

The centrifugal-type water pump circulates the engine coolant through the cylinder block, cylinder head, radiator and the oil cooler (Figure 4) The 8V-92 water pump is mounted on the engine front cover, and driven by the front camshaft gear. The Series 60 water pump is mounted on the rear of the engine gear case, and driven by the pump drive gear via the bull gear. If maintenance should need to be performed on the water pump, refer to the DDC Maintenance Manual (Section 5).



1. SURGE TANK
2. RECIRCULATING HOSE MAKE−UP
3. SURGE TANK TUBE
4. SURGE TANK TO RECOVERY TANK TUBE
5. EMERGENCY FILLCAP
6. VALVE PRESSURE RELIEF
7. CROSSOVER TUBE (8V−92)
8. RADIATOR (8V−92)
9. COOLANT RECOVERY TANK
10. COOLANT RECOVERY PUMP
11. COOLANT RECOVERY TANK FILLCAP
12. LEFT−HAND RADIATOR INLET TUBE (8V−92)
13. RIGHT−HAND RADIATOR INLET TUBE (8V−92)
14. RADIATOR OUTLET TUBE (8V−92)

Figure 1. Cooling System Components

THERMOSTAT AND HOUSING

The Series 60 engine has only one thermostat housing, and is fitted with a (190°F) thermostat. Upon cold engine starting, the coolant flow is blocked or restricted by the thermostat to the radiator module.

The 8V-92 engine has two thermostat housings, one on each cylinder head, fitted with (180°F) thermostats. Upon cold engine starting, the coolant flow is blocked or restricted by the thermostats to the radiator module. A bypass tube between the housing provides circulation within the engine during the warm-up period.

NOTE: The thermostat housings have provisions for a coolant over-temperature alarm switch, (independent of DDEC), to be installed.

COOLANT FILTER ASSEMBLY

An optional Nalcool 3000™ spin-on coolant additive filter assembly is available for installation on the 8V-92 cooling systems (Figure 2). The Series 60 engine installations features this Detroit Diesel approved coolant filter assembly as standard equipment.

Generic coolant mixtures may require additional inhibitors like Nalco or Penray's Nalcool 3000™ liquid or filter type precharge. Coolant additives like the Need-Release™ filter are normally used with the DDC Powercool™ coolant formulas.

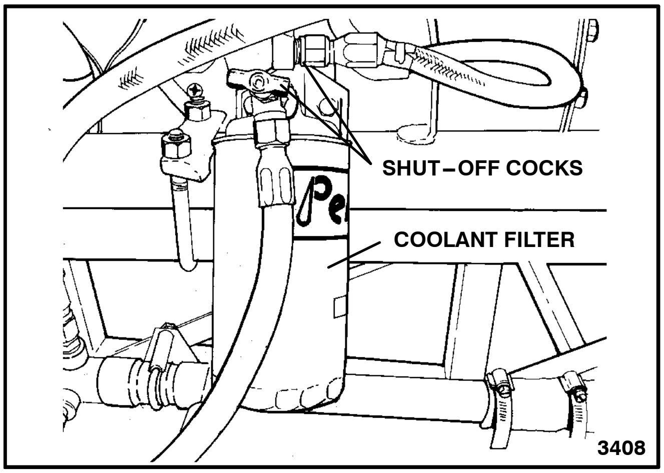


Figure 2. Coolant Filter

NOTE: Compatibilities of other brands of replacement inhibitor filter elements with a given coolant formula should not be taken for granted.

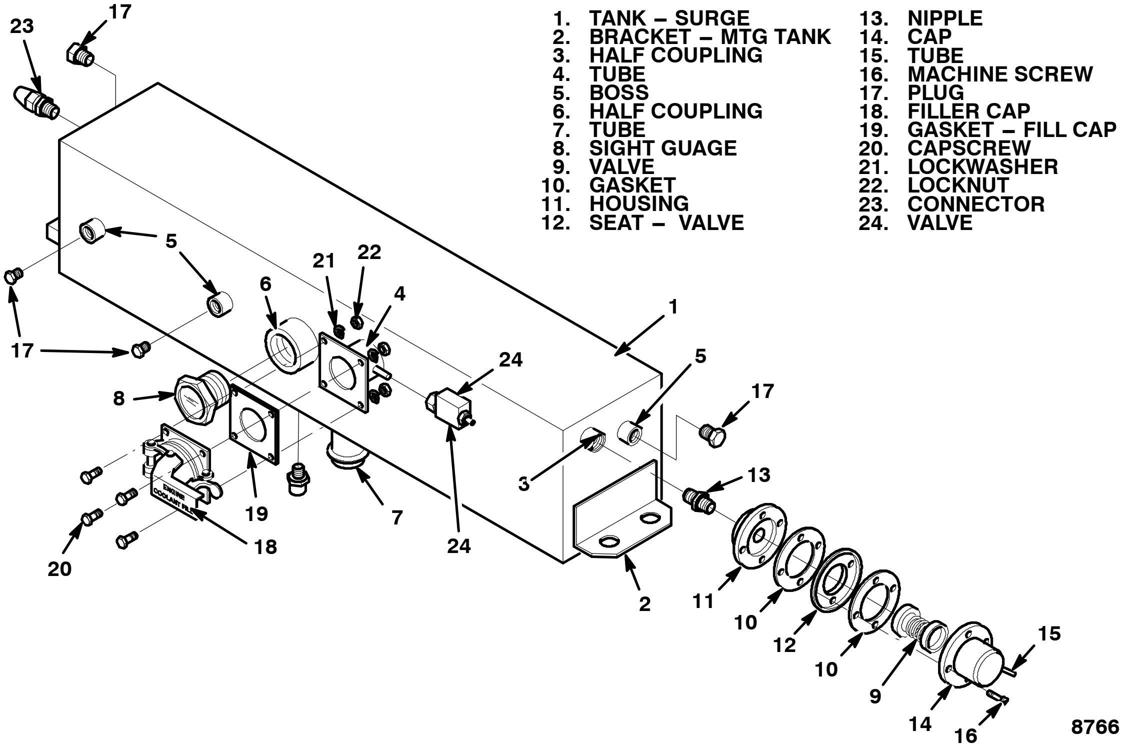
OPERATION

COOLANT RECOVERY SYSTEM

BASIC SYSTEM

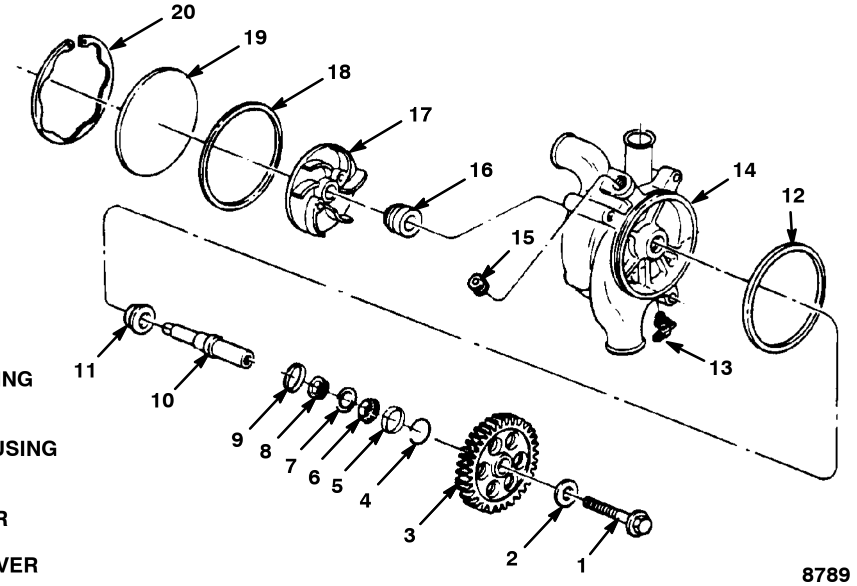
Turn coach master switch on. Fill the recovery/holding tank full with coolant, and switch pump on at control box. After filling to required level, release switch. The telltale light should go off.

NOTE: Observe the surge tank's sight glass while filling to avoid overfilling coolant level, and keep coolant supply in the recovery tank full while filling radiator module.



1. TANK – SURGE
2. BRACKET – MTG TANK
3. HALF COUPLING
4. TUBE
5. BOSS
6. HALF COUPLING
7. TUBE
8. SIGHT GUAGE
9. VALVE
10. GASKET
11. HOUSING
12. SEAT – VALVE
13. NIPPLE
14. CAP
15. TUBE
16. MACHINE SCREW
17. PLUG
18. FILLER CAP
19. GASKET – FILL CAP
20. CAPSCREW
21. LOCKWASHER
22. LOCKNUT
23. CONNECTOR
24. VALVE

Figure 3. Surge Tank Assembly



1. RETAINING BOLT
2. WASHER
3. GEAR, WATER PUMP DRIVE
4. SNAP RING
5. BEARING RACE
6. BEARING
7. SPACER RINGS (2)
8. BEARING
9. BEARING RACE
10. DRIVE SHAFT
11. OIL SEAL
12. O–RING, WATER PUMP HOUSING
13. DRAIN COCK
14. HOUSING, WATER PUMP
15. PIPE PLUG, WATER PUMP HOUSING
16. WATER SEAL
17. IMPELLER
18. O–RING, WATER PUMP COVER
19. WATER PUMP
20. SNAP RING, WATER PUMP COVER

Figure 4. Water Pump Assembly

AUTOMATIC SYSTEM

When coolant in the surge tank falls below the sensor level, the sensors go to ground, activating the pump and drivers telltale pulsing light. The pump automatically fills the cooling system until coolant reaches sensors. The pump will not operate when the recovery/holding tank is empty

> **NOTE:** The surge tank is fitted with two sensors to eliminate the possibility of inadvertent pump operation during high speed cornering. The low coolant warning (steady) and the automatic recovery function (pulse) utilize the same driver's telltale light.

MAINTENANCE

DRAINING & REFILLING SYSTEM

DRAINING (SYSTEM)

The cooling system may be completely or partially drained by using the following procedures.

⚠ CAUTION ⚠

After draining the cooling system always attach a suitable tag to the steering wheel indicating that the cooling system is dry.

To drain the entire system leave the center tunnel isolation gate valves (Figures 5 and 6) open and follow this procedure:

1. Depress the vent button on filler cap and open.
2. Remove drain plugs at the return line tee (8V-92), located below the engine water pump (Figure 7).
3. Remove the drain plugs from the engine oil cooler and the air compressor (Figures 8 and 9).
4. On coaches equipped with a coolant filter, open both drain cocks.

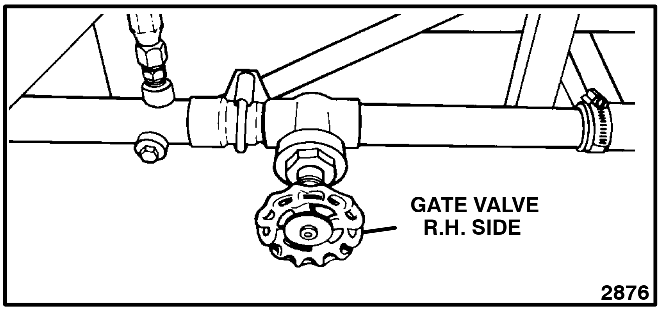


Figure 5. Return Line Valve

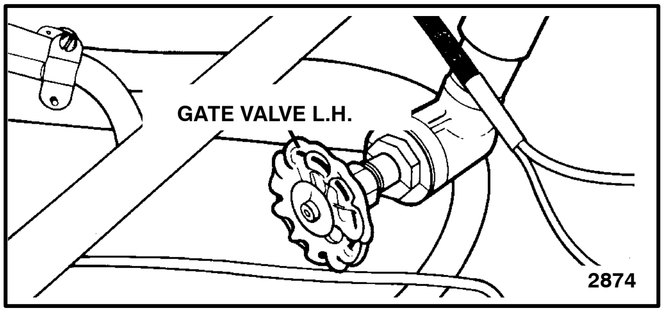


Figure 6. Feed Line Valve

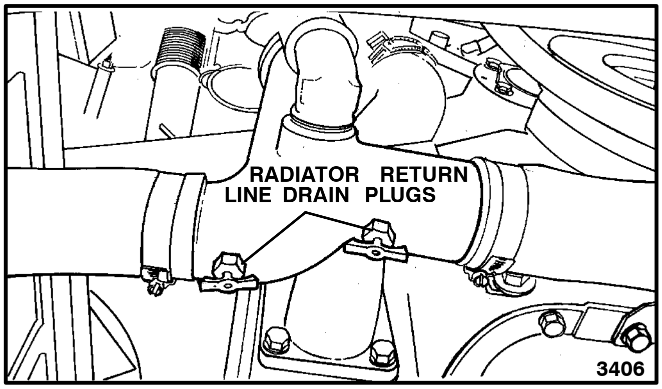


Figure 7. Return Line Drain

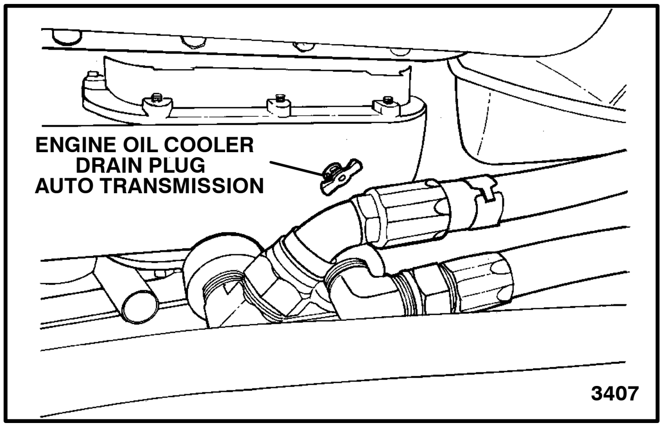


Figure 8. Oil Cooler Drain

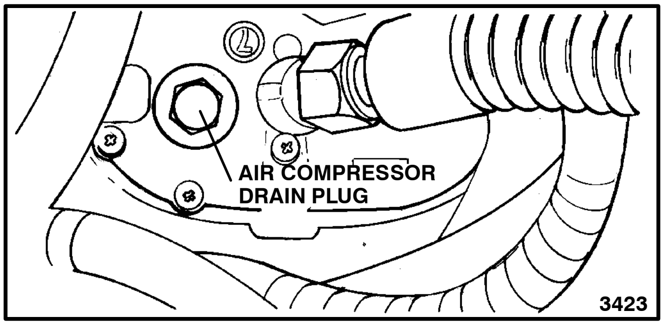


Figure 9. Air Compressor Drain

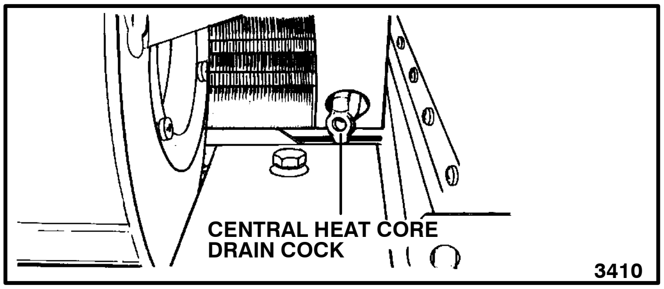


Figure 10. Central Heat Core Drain

5. Open the central heat core drain cock (Figure 10).

6. After coolant has drained from all locations, open the bleeder valve on the central heat core and driver's heater core (Figure 11).

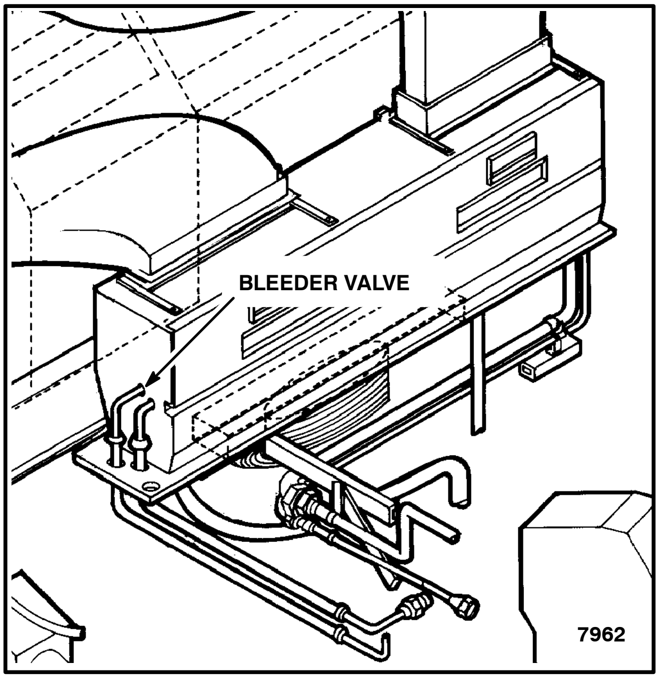


Figure 11. Driver's Heater Core Bleed

DRAINING (ENGINE COMPARTMENT)

With the isolation gate valves closed, follow the "System Draining" procedures 1 thru 4.

REFILLING

> **IMPORTANT: For maximum effectiveness, clean your cooling system with Nalprep 2001 before filling.**

The cooling system can be filled through the surge tank filler cap by a remote pumping device and coolant source, or by using the coolant recovery system's pump and reservoir. If using the coolant recovery system method, follow the instructions found under "Operation".

> **NOTE:** Open surge tank filler tube cap while filling. When filling systems equipped with the 8V-92, open the bypass tube's petcock and allow air to bleed out as engine block fills.

⚠ CAUTION ⚠

Never pour cold coolant into a hot engine. The sudden change in temperature may crack the cylinder head or block.

COOLANT RECOVERY SYSTEM

At the 10,000 mile service interval, check operation of the pump and the telltale warning light function. Check the system tank for correct level and refill with proper coolant as necessary.

REPLACEMENT

Pump

1. Turn main battery disconnect switch to "OFF".
2. Disconnect the electrical harness to pump motor located above the RH rear side service door.
3. Disconnect the inlet and outlet hoses from recovery tank and surge tank at the pump housing.
4. Unfasten pump and motor assembly from coach and remove.
5. Reinstall pump and motor assembly in reverse order.

Reservoir Tank

1. Disconnect the outlet and deareator hose lines from recovery tank.

ENGINE WATER PUMP

The 8V-92 water pump's water seal should be replaced every 200,000 miles (321,800 km). Refer to the DDC Maintenance Manual.

> **NOTE:** Inspect the water pump drain hole at bottom (Series 60) or at rear (8V-92) of pump every six months, making sure it is open. Coolant leakage from hole during engine operation could indicate a seal failure.

THERMOSTAT AND HOUSING

Check the thermostats and the housing seals every 200,000 miles (321,800 km). Refer to the DDC Maintenance Manual.

COOLANT FILTER ASSEMBLY

MCI recommends that the inhibitor levels should be checked every 500 hours or 15,000 miles (24,000 km). Nalcool Need-Release™ additive filters (DDC P/N 23516489) should be changed every 100,000 miles

(161,000 km). Other generic precharge filter elements may need replacement at shorter intervals. Only a Detroit Diesel approved precharge filter and its replacement element (DDC P/N 23507189) should be used on the Series 60.

MCI recommends that the optional Perry water softener and contaminent filter assembly be changed every 800 hours or 20,000 miles (32,000 km). Use replacement filter element (P/N 6F-8-131) only for these filter assemblies.

IMPORTANT: Cooling system integrity can be enhanced when these types of cooling system contaminant catch filters are used.

NOTE: Follow the manufacturer's instructions when installing new filter element.

The filter assembly on 8V-92 engines can be serviced from the RH rear side service door. The Series 60's filter element is serviced from the LH rear side service door.

⚠ CAUTION ⚠

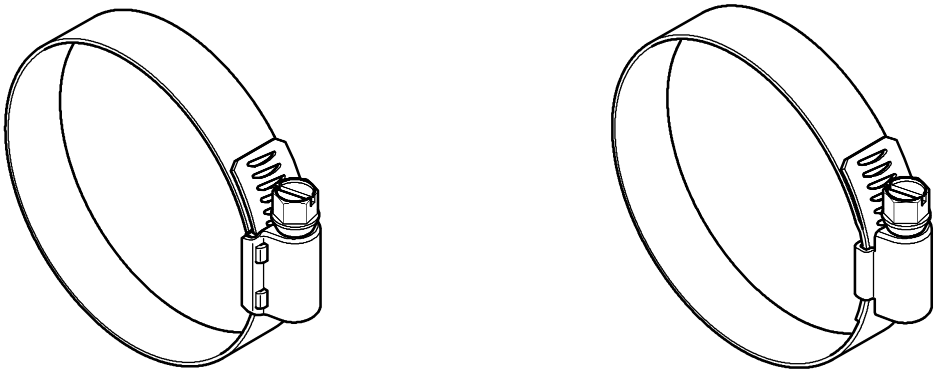
Some concern exists as to the use of magnesium alloys in the construction of some filter elements. The magnesium element is attacked and broken down by some coolant solutions. The dissolved magnesium can be deposited in the hottest zones of the engine where heat transfer is most critical. The use of an aluminum or zinc support plate in preference to magnesium is recommended to eliminate the potential of these deposits.

High chloride coolants will have a detrimental effect on the water-softening capabilities of systems using ion-exchange resins. Accumulations of calcium and magnesium ions removed from the coolant and held captive by the zeolite resin can be released into the coolant by a regenerative process caused by high chloride-content solutions.

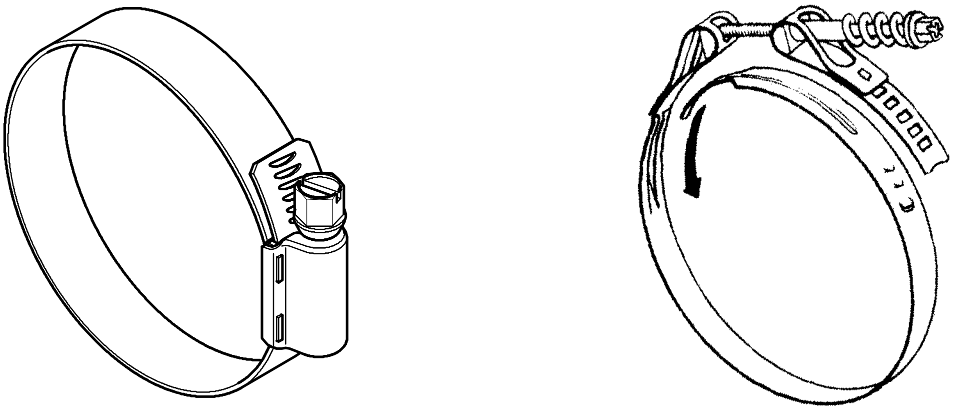
HOSES AND CLAMPS

HOSES

Serious overheating problems occur due to collapsing or clogging of system passages caused by old and deteriorated hose materials. Swollen, cracked or worn out hoses and loose hose connections are frequent causes of cooling system problems.



Aero Seal Clamp **Power Seal Clamp**



Hi-Torque Heavy Duty Clamp **Stepless Screw Clamp**

Figure 12. Standard Screw Clamps

Connections should be inspected periodically and hose clamps tightened. Replace any hose found to be cracked or swollen. When installing a new hose, clean pipe connections and apply a thin layer of a non-hardening sealing compound. Replace worn out clamps or clamps that pinch hoses.

Problems may develop from leaks and seepage at the engine water pump and thermostat housings hose connections. These may be caused by deformation and rough surfaces on the castings at the hose mounting surfaces. It is recommended that Dow Corning RTV-102 Compound be applied to cast surfaces prior to hose installation.

⚠ CAUTION ⚠

Castings should be clean and free of oil and grease before applying compound. No other sealer should be used with RTV compound.

CLAMPS

Some of the various standard screw clamps used by MCI are shown in (Figure 12). Recommended initial and retorque values for the clamps used on coolant hoses in both installations are shown in tables located at end of this section.

The Oetiker screw clamp is a stepless design that provides a 360 degree seal on hoses, not found on conventional worm-drive clamps. The stepless design closes and seals tightly at low torque values. Note the following procedure for installing clamps.

1. Open screw as far as possible, taking care not to disengage from nut (Figure 13).
2. Slip clamp over or around hose, and engage the three locking tabs into the windows (Figure 14).
3. Engage locking tabs in tightest location before tightening clamp.

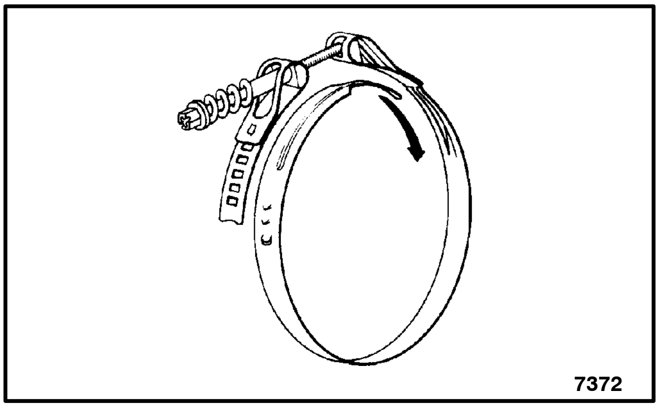


Figure 13. Opening Clamp

NOTE: Be sure that tongue is engaged in groove area before tightening.

4. Snug clamp to hose, and tighten 2-3 full revolutions to set clamp seal (Figure 15).

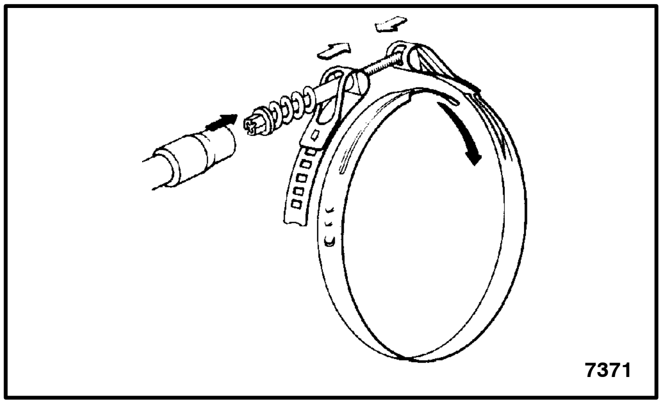


Figure 14. Fitting Clamp to Hose

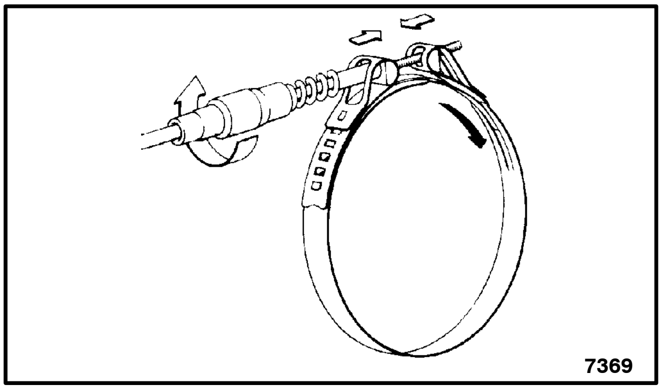


Figure 15. Snugging Clamp

NOTE: Leave a 3/16 inch (4 mm) gap between D-nuts to allow the clamp to automatically adjust to service changes (Figure 16). Locking tab engagement may need to be readjusted to attain proper gap.

The Oetiker spring clamps do not require a high torque to achieve an effective seal. The average torque necessary for sealing should not exceed 18 in-lbs (2 N·m).

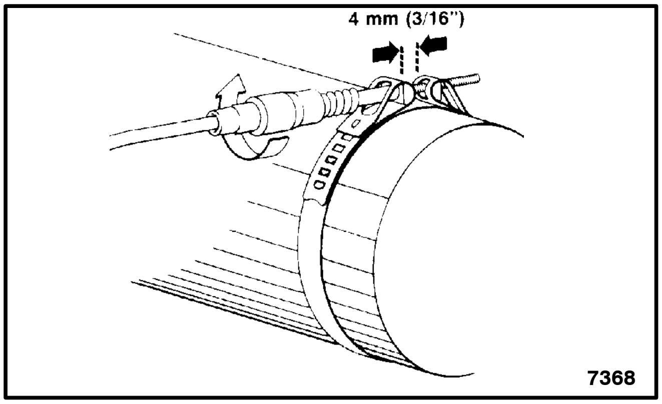


Figure 16. Proper Clamp Adjustment

AERO-SEAL AND POWER-SEAL CLAMPS

MCI PART NO.	SIZE INCHES MIN. - MAX.	SIZE MM MIN. - MAX.	INITIAL RECOMMENDED TORQUE (IN-LBS)	RETORQUING VALUE (IN-LBS)
19-4-117	½ - 29⁄32	12.700 - 23.019	50	70-80
19-4-5	9⁄16 - 1 1⁄16	14.288 - 26.988	50	70-80
19-4-107	⅝ - 1¼	15.875 - 31.750	50	70-80
19-4-142	11⁄16 - 15⁄16	17.463 - 23.813	50	70-80
19-4-109	11⁄16 - 1¼	17.463 - 31.750	50	70-80
19-4-110	13⁄16 - 1¾	20.638 - 44.450	50	70-80
19-4-96	⅞ - 1¾	22.225 - 44.450	50	70-80
19-4-97	1⅜ - 2¼	25.775 - 57.150	50	70-80
19-4-111	1⅝ - 2⅝	26.988 - 66.675	50	70-80
19-4-177	2 1⁄16 - 3	52.388 - 76.200	45	50-60
19-4-98	2⅜ - 3¼	60.325 - 82.550	50	70-80
19-4-145	3 1⁄16 - 4	77.788 - 101.600	50	70-80

HI-TORQUE HEAVY-DUTY CLAMPS (100% STAINLESS STEEL)

MCI PART NO.	SIZE INCHES MIN. - MAX.	SIZE MM MIN. - MAX.	INITIAL RECOMMENDED TORQUE (IN-LBS)	RETORQUING VALUE (IN-LBS)
19-4-101	1¼ - 2⅛	31.750 - 53.975	90-100	90
19-4-88	1¼ - 2⅝	31.750 - 66.675	90-100	90
19-4-102	1¾ - 2⅝	44.450 - 66.675	90-100	90
19-4-103	2¼ - 3⅛	57.150 - 79.375	90-100	90
19-4-104	2¾ - 3⅝	69.850 - 92.075	90-100	90
19-4-113	3¼ - 4⅛	82.550 - 103.188	90-100	90
19-4-119	3¾ - 4⅝	95.250 - 117.475	90-100	90
19-4-118	4¼ - 5⅛	107.950 - 130.175	90-100	90
19-4-108	4¾ - 5⅝	120.650 - 142.875	90-100	90
19-4-123	5¾ - 6⅝	146.050 - 158.275	90-100	90
19-4-430	6¼ - 7⅛	158.750 - 180.975	90-100	90
19-4-124	6¾ - 7⅝	171.450 - 193.675	90-100	90
19-4-131	7¼ - 8⅛	184.150 - 206.375	90-100	90
19-4-174	8¼ - 9⅛	209.550 - 231.775	90-100	90

CONSTANT-TORQUE CLAMPS

MCI PART NO.	SIZE		INITIAL RECOMMENDED TORQUE (IN-LBS)	RETORQUING VALUE (IN-LBS)
	INCHES MIN. MAX.	MM MIN. MAX.		
19-4-204	1⅜ - 1 9⁄16	35.500 - 40.000	18	NA
19-4-205	1 9⁄16 - 1¾	39.500 - 45.000	18	NA
19-4-206	1 15⁄16 - 2⅛	49.500 - 55.000	18	NA
19-4-207	2⅛ - 2⅜	54.500 - 60.000	18	NA
19-4-208	2 5⁄16 - 2 9⁄16	59.500 - 65.000	18	NA
19-4-209	2 9⁄16 - 2¾	64.500 - 70.000	18	NA
19-4-212	3 5⁄16 - 3½	84.500 - 90.000	18	NA
19-4-231	-	-	18	NA

SPECIFICATIONS

THERMOSTATS (8V-92 ENGINE)

Part Number	(8V-92) DDC #23503825
Temperature Range	177-197°F (80-91°C)

THERMOSTATS (SERIES 60 ENGINE)

Part Number	(Series 60) DDC #8929878
Temperature Range	186-207°F (85-97°C)

TEMPERATURE GAUGE (ENGINE COMPARTMENT)

Manufacturer	Stewart-Warner
Part Number	8R-28-4
Operating Range	100-265°F (38-129°C)

TEMPERATURE GAUGE (INSTRUMENT PANEL)

Manufacturer	Stewart-Warner
Part Number	(Domestic) 7K-13-8 (Metric) 7K-13-15
Operating Range	100-250°F (38-121°C)

PRESSURE RELIEF VALVE (SURGE TANK)

Manufacturer	A.C. Spark
Part Number	6R-8-49
Pressure Setting	7 psi (43 kPa)

SHUTTERSTAT FILTER ASSEMBLY

Manufacturer	Kysor
Lubrication/Cleaning Fluid	6-10-33
Part Number	6-10-20

COOLANT FILTER (OPTIONAL 8V-92)

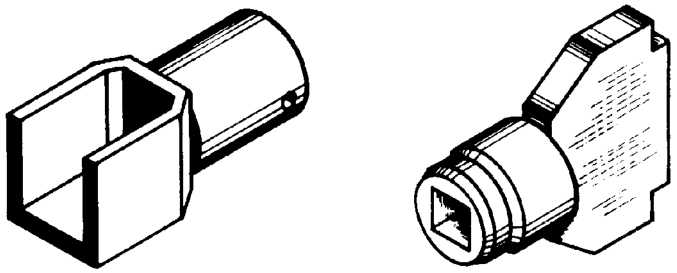
Manufacturer	Perry
Type	Spin-On
Part Number (Assembly)	6J-8-30
Part Number (Replacement Element)	6F-8-131

INHIBITANT FILTER (SERIES 60)

Manufacturer	(Detroit Diesel Approved)
Type	Spin-On
Part Number (Replacement Element 16 oz.)	DDC #23507189
Part Number (Replacement Element 4 oz.)	DDC #23507545

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES, AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED AT THE SERVICE FACILITY.



20 – 32 SOCKET – TIGHTENING WATER LINE ELBOWS AT ENGINE

20 – 60 TOOL – SIGHT GAUGE GLAND INSTALLATION & REMOVAL

4165

SECTION 6C

COOLANT

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 6C-1
Components 6C-1
Maintenance 6C-3
Specification 6C-4

GENERAL DESCRIPTION

The function of coolant is to absorb heat which develops as a result of the combustion process in the engine. The engine's water pump circulates coolant through the engine oil cooler, block, cylinder heads, after cooler (if equipped) and coach compartment heating circuit. It then flows through the thermostats to the radiator module and back to the water pump completing the cycle. Anything that interferes with this process of heat transfer can cause engine components to overheat, often resulting in serious engine damage.

COMPONENTS

TEMPERATURE CONTROL

Some major components that help control the engine's cooling system are the radiator modules, surge tank and coolant recovery systems, as well as other engine related components such as water pump and thermostat; these are covered in more detail in other sub-sections. These components along with the coolant itself, are responsible for keeping the engine operating temperature within specifications.

NOTE: Coolant temperature instability will result from improper component temperature actuation or operating sequence.

COOLANT TEMPERATURE

The engines are designed to operate in conjunction with the cooling system components to regulate coolant temperature. The cooling system components must operate in proper sequence to prevent coolant temperature instability and/or engine overheating. An improper operating sequence can also have a detrimental effect on the life of the components.

CAUTION

The coolant's maximum temperature must not be exceeded by any engine operating condition, regardless of altitude, type of coolant used, or cooling system condition. Exceeding this limit can result in engine malfunction or serious damage.

The 8V-92's **nominal temperature** for component actuation and operating range is shown in (Figure 1) for the 180°F (82°C) thermostat and shutterstat. The Series 60's **nominal temperature** for component actuation and operating range are shown in (Figure 2). These temperature settings and ranges should be maintained under any engine operating condition, regardless of operating altitude, type of coolant used, or cooling system condition. Exceeding the settings will unnecessarily increase the engine coolant and lubricating oil temperature.

MAINTENANCE

A routine maintenance program for the cooling system components is essential to ensure maximum system efficiency, and trouble-free operation. Many different variables must be considered when formulating your specific maintenance program. Observing some of the following guidelines and specifications may help in determining a proper course of action.

NOTE: Specific instructions are set forth concerning: coolant testing, system cleaning and cold climate cautions.

COLD CLIMATES

In colder regions, where temperatures reach below 32°F (0°C), antifreeze must be used. In climates of this type engines and cooling systems both experience thermal fluctuations, and therefore, should be inspected more often for gasket and hose deterioration. Gaskets or hoses that show signs of leakage should be tightened or replaced as necessary, to avoid the possibility of coolant leaking into engine or exhaust gases blowing into cooling system.

CAUTION

If the coolant solution should ever freeze, place coach in a warm environment until completely thawed. Severe engine damage can occur if engine is run while cooling system is frozen.

PERIODIC MAINTENANCE

Check coolant level in surge tank. If low, fill with coolant and inspect for any signs of leakage in the system.

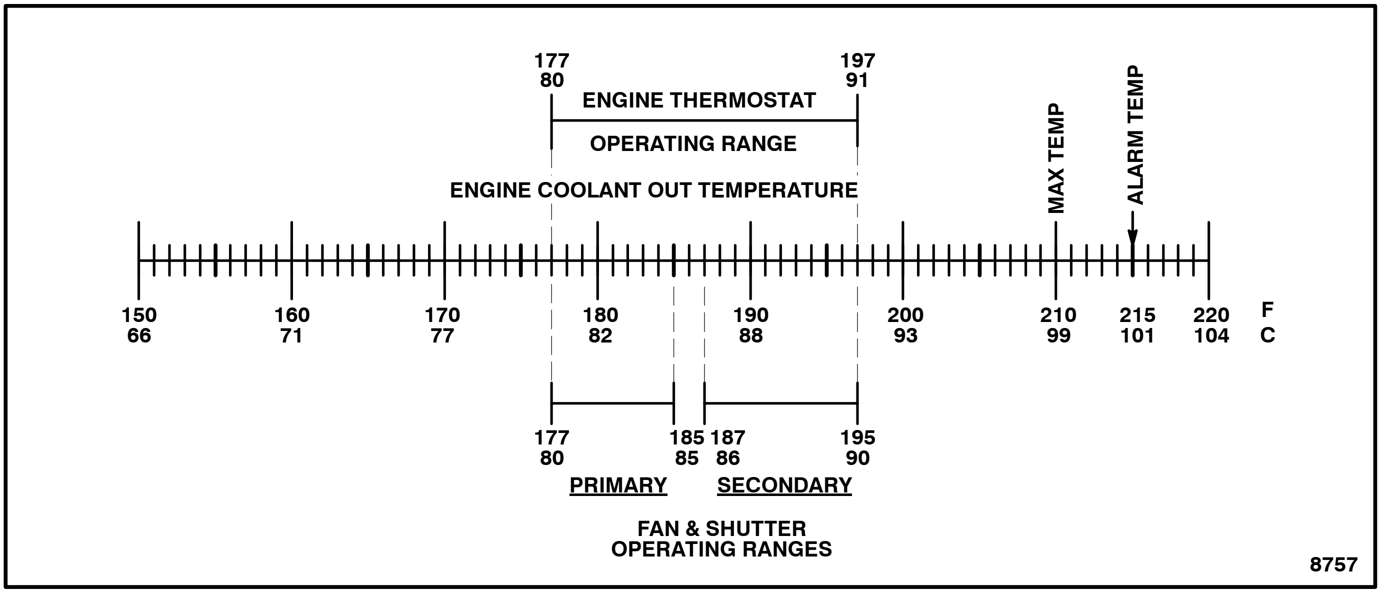

177
80
197
91
ENGINE THERMOSTAT
OPERATING RANGE
ENGINE COOLANT OUT TEMPERATURE
MAX TEMP
ALARM TEMP
150 66
160 71
170 77
180 82
190 88
200 93
210 99
215 101
220 104
F
C
177 80
185 85
187 86
195 90
PRIMARY
SECONDARY
FAN & SHUTTER OPERATING RANGES
8757

Figure 1. Nominal Temperature (8V-92)

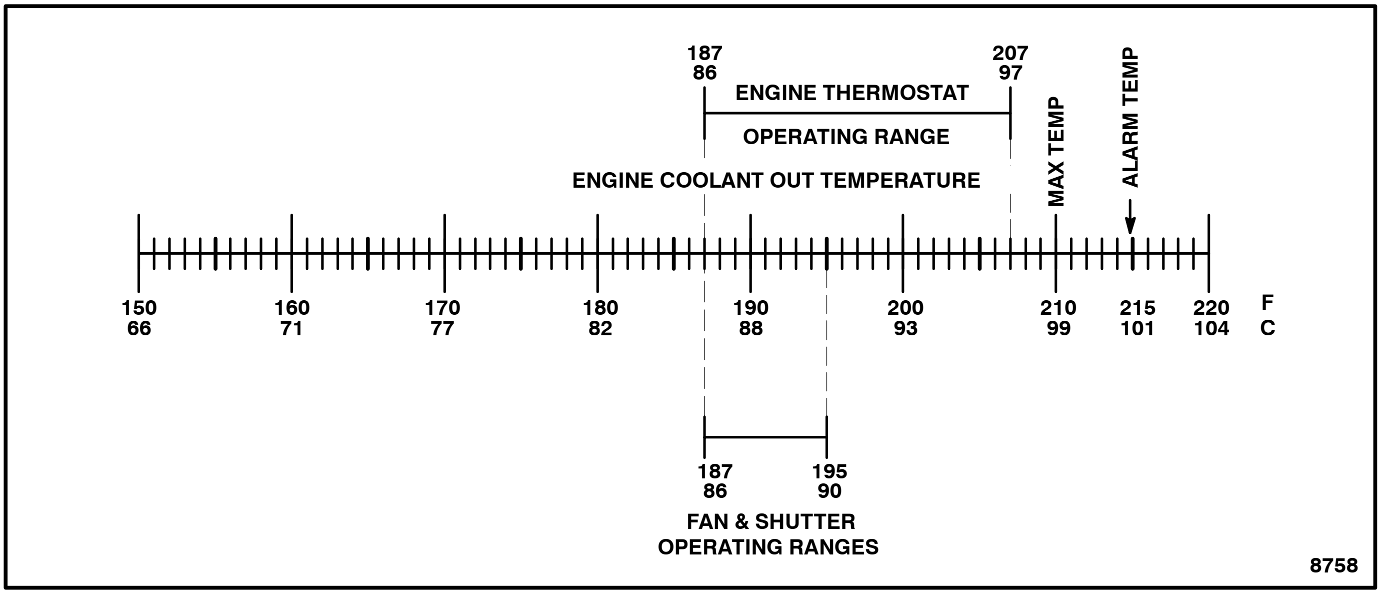

187
86
207
97
ENGINE THERMOSTAT
OPERATING RANGE
ENGINE COOLANT OUT TEMPERATURE
MAX TEMP
ALARM TEMP
150 66
160 71
170 77
180 82
190 88
200 93
210 99
215 101
220 104
F
C
187 86
195 90
FAN & SHUTTER OPERATING RANGES
8758

Figure 2. Nominal Temperature (Series 60)

INTERVAL: 10,000 MILES (16,000 km)

Check coolant and inhibitor concentration strength with a hydrometer. See “Testing Coolant” later in this sub-section.

INTERVAL: 20,000 MILES (32,000 km)

1. Check belts for condition and tension. Tighten loose belts and replace those worn or frayed.

2. Check and inspect water pump operation and installation. A leaking pump can cause corrosion of engine and cooling system components.

3. Inspect the radiator and all hoses for leakage or signs of deterioration, and correct immediately.

4. Replace the coolant filter element if equipped, using Perry PFC-228 (PN 6F-8-131) replacement element. To remove the filter element, close the two shut-off cocks at the filter mounting head and remove the old element.

INTERVAL: 100,000 MILES (160,900 km)

1. Drain and clean the radiator cores with low pressure air to remove all dirt and sediment.

2. Check and tighten radiator mounts as required.

3. Replace the coolant inhibitor Need-Release filter element if equipped (P/N 23516489)

INTERVAL: 200,000 MILES (321,800 km)

At this interval the antifreeze must be drained, discarded in an appropriate manner, and the cooling system thoroughly cleaned.

1. Drain and clean the cooling system.

2. Refill the entire system with new coolant and inhibitor solution.

TESTING COOLANT

Coolant should be tested every 150 hours or 10,000 miles (1600 km) to ensure that proper protection and inhibitor levels are maintained within the following ranges (Figure 3)

DDC SELECTED PRODUCTS SYSTEM COOLANT ADDITIVE VALUES WITH GM6038-M OR ASTM D 4985

	Min. PPM	Max. PPM
Boron (B)	1000	1500
Nitrite (NO_2)	800	2400
Nitrate s(NO_3)	1000	2000
Silicon (Si)	50	250
Phosphorous (P)	300	500
pH	8.5	10.5

To insure proper freeze and/or corrosion protection, always test the antifreeze solution before and after adding water or antifreeze, using a standard-type of antifreeze tester. With coolant slightly warm, fill and empty tester several times to warm it before making actual test. Keep tester clean inside and out.

Some testers will indicate the correct freezing point only when the test is made at a specific coolant temperature. Other testers are provided with a table or chart indicating freezing points at various coolant temperatures. Disregarding the coolant’s temperature at time of testing may result in erroneous test results.

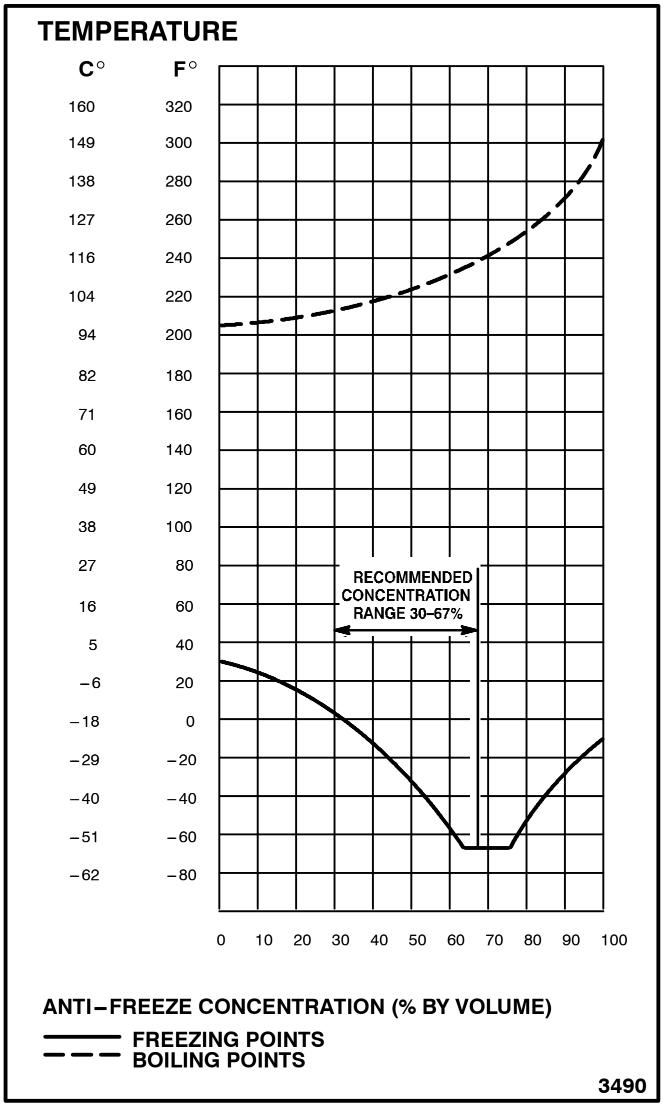


Figure 3. Coolant Concentration Graph

Use Nalco Chemical Company nitrate test kits (CO-318) to measure the nitrate concentration. Always follow the manufacturer’s recommended test procedures. A coolant analysis program is also available through local DDC distributors (P/N 23516921).

CLEANING COOLING SYSTEM

Commercial radiator cleaners of alkaline or acid type may be used to perform cooling system cleaning. Exercise extreme caution and follow the manufacturer's recommendations when using these types of cleaners.

Inspect all components that make up the cooling system and make necessary repairs at this time. Refill the cooling system with a recommended ethylene glycol-base antifreeze and water solution at the required concentration. Add required DDC-selected cooling system inhibitors. After filling, run engine until thermostats open and top off to recommended full level. Reinstall fill/pressure cap.

SPECIFICATION

WATER

Whether of drinking quality or not, any water will produce a corrosive environment in the cooling system, and the mineral content may permit scale deposits to form on internal cooling system surfaces, causing cylinder head cracking and engine damage. Therefore, water selected as a coolant must be properly treated with inhibitors to control corrosion and scale deposition.

TABLE 1

	PARTS PER MILLION	GRAINS PER GALLON *
Chloride (Maximum)	40	2.5
Sulfates (Maximum)	100	5.8
Total Dissolved Solids (Maximum)	340	20
Total Hardness (Maximum)	170	10
Refer to Table 2 for evaluation of water intended for use in a coolant solution.		*4.5

8759

Figure 4. Solids In Water Chart

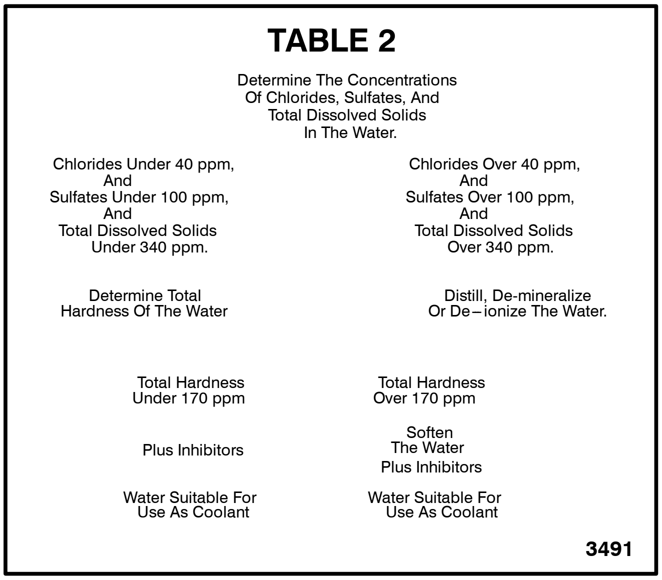


TABLE 2
Determine The Concentrations Of Chlorides, Sulfates, And Total Dissolved Solids In The Water.
Chlorides Under 40 ppm, And Sulfates Under 100 ppm, And Total Dissolved Solids Under 340 ppm.
Chlorides Over 40 ppm, And Sulfates Over 100 ppm, And Total Dissolved Solids Over 340 ppm.
Determine Total Hardness Of The Water
Distill, De-mineralize Or De–ionize The Water.
Total Hardness Under 170 ppm
Total Hardness Over 170 ppm
Plus Inhibitors
Soften The Water
Plus Inhibitors
Water Suitable For Use As Coolant
Water Suitable For Use As Coolant
3491

Figure 5. Water Evaluation Chart

To determine if a particular water is suitable for use as a coolant when properly inhibited, the following characteristics must be considered: the concentration of chlorides and sulfates, total hardness, and total dissolved solids.

Chlorides and/or sulfates tend to accelerate corrosion, while hardness (percentage of magnesium and calcium salts broadly classified as carbonates) causes deposits of scale. Total dissolved solids may cause scale deposits, sludge deposits, corrosion, or a combination of any of these. Chlorides, sulfates, magnesium and calcium are among the materials which make up dissolved solids. Water within the limits specified in Table 1 (Figure 4) is satisfactory as an engine coolant when proper inhibitors are added. The procedure for evaluating water intended for use in a coolant solution is shown in Table 2 (Figure 5).

ANTIFREEZE

When freeze protection is needed or required, use an ethylene glycol antifreeze formula that meets the GM 6038-M formulation, which limits silicate to 0.15% maximum, or an equivalent formulation meeting the 0.15% maximum silicate and GM 1899-M performance requirements. Ethylene glycol-based antifreeze meeting ASTM D 4985 requirements is also acceptable for use in Detroit Diesel engines.

NOTE: A 50/50% antifreeze-to-water solution using Powercool™ or Powercool Plus coolant formulas are now normally used as the factory-fill.

Antifreeze solutions should be used year-round to provide freeze protection in the winter, boil-over protection in the summer, and a stable environment for seals and hoses in the cooling system of the engine. Concentrations over 67% adversely affect freeze protection, heat transfer rates, and silicate stability. Concentrations below 40% offer little freeze, boil over or corrosion protection.

Methyl alcohol base antifreeze is not recommended because of its affect on the non-metallic components of the cooling system and because of its low boiling point. Methoxy propanol base antifreeze is not recommended due to the presence of fluoroelastomer seals in the cooling system.

NOTE: Failure to use and maintain antifreeze/water coolant mixture at sufficient concentration levels can result in damage to the cooling system and its related components. Conversely, overconcentration of antifreeze and/or inhibitor can result in poor heat transfer leading to engine overheat, additive dropout, or both. Always maintain concentrations at recommended levels.

CORROSION INHIBITORS

Corrosion inhibitors are water-soluble chemical compounds which provides corrosion protection, cavitation suppression, pH control, and prevents scale. Some of the more commonly used corrosion inhibitors are chromates, borates, nitrates, nitrites, silicates, and soluble oils. Depletion of all types of inhibitors occurs through normal operation. Therefore, strength levels must be maintained by adding inhibitors as required after testing the coolant. Non-chromate inhibitors (borates, nitrates, nitrites, etc.) provide corrosion protection in the cooling system with the basic advantage that they can be used with either a water or water-and-antifreeze solution.

NOTE: DDC requires specific supplemental inhibitors to be added to their coolant formula at initial fill and maintained at the proper protection level thereafter. DDC-selected cooling system products are nitrate-borate based formulations. These products can be used with either water or water-and-antifreeze solutions and provide corrosion protection, pH control, and water softening. They offer the additional advantage of a simple on-site test to determine protection level.

CHROMATES (NOT RECOMMENDED)

Chromate inhibitors should not be used in antifreeze solutions. Chromium hydroxide, commonly called “green slime,” can result from the use of chromate inhibitors with antifreeze. This material deposits on the cooling system passages, reducing the heat transfer rate and resulting in engine overheating. Engines which have operated with a chromate-inhibited water must be chemically cleaned before the addition of antifreeze. A commercial heavy-duty descaler should be used in accordance with the manufacturer’s recommendation for this purpose.

NOTE: Sodium chromate and potassium dichromate are two of the most commonly used water system corrosion inhibitors. Care should be exercised in handling these materials due to their toxic nature.

SOLUBLE OILS (NOT RECOMMENDED)

Soluble oil is not recommended as a corrosion inhibitor. It has been used as a corrosion inhibitor for many years. It has, however, required very close attention relative to the concentration level due to adverse effects on heat transfer if the concentration exceeds 1% by volume. For example, 1.25% of soluble oil in the cooling system increases fire deck (top of cylinder) temperature by 6%, and 2.5% concentration raises fire deck temperature by 15%.

The importance of a properly inhibited coolant cannot be overstressed. A coolant which has insufficient inhibitors, the wrong inhibitors, or - worse - no inhibitors at all invites the formation of rust and scale deposits within the cooling system. Rust, scale, and mineral deposits can wear out water pump seals and coat the walls of the cylinder block water jackets and the outside walls of the cylinder liners. As these deposits build up, they insulate the metal and reduce the rate of heat transfer. For example, a 1/16” deposit of rust or scale on 1” of cast iron is equivalent to 4-1/4 inches of cast iron in heat transferability.

An engine affected in this manner gradually overheats over a period of weeks or months. Liner scuffing, scoring, piston seizure, and cylinder head cracking are the inevitable results. An improperly inhibited coolant can also become corrosive enough to “eat away” coolant passages and seal ring grooves and cause coolant leaks to develop. If sufficient coolant accumulates on top of a piston, a hydrostatic lock can occur while the engine is being started. This, in turn, can result in a bent connecting rod.

An improperly inhibited coolant can also contribute to cavitation erosion. Cavitation erosion is caused by the collapse of bubbles (vapor pockets) formed at the coolant side of an engine component. The collapse results from a pressure differential in the liquid caused by the vibration of the engine part. As bubbles collapse, they form pin points of very high pressure. Over a period of time, the rapid succession of millions of tiny bursting bubbles can wear away (erode) internal engine surfaces. Components, such as fresh water pump impellers and cylinder liners are especially susceptible to cavitation erosion. In extreme cases, their surfaces can become so deeply pitted that they appear to be spongy, and holes can develop completely through them.

INHIBITOR SYSTEMS

NOTE: Although some antifreezes contain inhibitors, supplemental inhibitor products may need to be added to coolant system’s initial fill, and maintained at their proper concentrations, to adequately protect engine against corrosion. Only non-chromate corrosion inhibitor supplements should be used in coolant solutions.

An inhibitor system is a combination of chemical compounds which provide corrosion protection, pH control, and water-softening ability. pH control is used to maintain an acid-free solution. The water-softening ability deters formation of mineral deposits. Inhibitor systems are available in various forms, such as coolant filter elements, liquid and dry inhibitor additives, and as integral parts of antifreeze.

A generic ethylene-glycol based coolant may require Nalco or Penray's Nalcool 3000™ liquid additive or filter type precharge additive (DDC P/N 23507189). Coolant additives like the Need-Release™ filter (DDC P/N 23516489) are normally used with the standard Powercool™ coolant formula. Special long-life coolants such as DDC Powercool Plus™ or Caterpillar Long-Life™ are available from the manufacturer, and do not require any additional coolant additives.

NOTE: It is imperative that the specific DDC-selected supplemental inhibitor products be added to all DDC engines. A precharge dosage must be used at the initial coolant fill and the maintenance dosage used at each service interval, unless the special long life coolant formulas are utilized.

Commercially packaged inhibitor systems are available which can be added directly to the engine coolant. Both chromate and non-chromate systems are available, and care should be taken regarding inhibitor compatibility with other coolant constituents. Other inhibitor additives and/or systems are also available such as:

- pH control chemicals are used to maintain an acid-free solution.
- Water-softening chemicals deter formation of mineral deposits.
- Cavitation suppression chemicals minimize the formation of vapor pockets, preventing erosion of cooling system surfaces.

Non-chromate inhibitor systems are recommended. These systems can be used with either water or water-and-antifreeze solutions and provide corrosion protection, pH control, and water softening. Most non-chromate inhibitor systems offer the additional advantage of a simple on-site test to determine protection level. Since they are added directly to the coolant, they require no additional hardware or plumbing.

All inhibitors become depleted through normal operation, and additional inhibitor must be added to the coolant as required to maintain original strength levels.

SILICATE/PHOSPHATE DROPOUT

NOTE: Over-inhibiting antifreeze solutions can cause silicate dropout. Always follow the supplier's recommendations on inhibitor usage and handling.

Excessive amounts of chemicals in the engine coolant can cause additive dropout, which creates a gel-type deposit that reduces heat transfer and coolant flow. Dropout may also occur in coolants using extremely hard water and/or unusually high operating temperatures.

The gel takes on the color of the coolant solution in the wet state, but appears as a white powdery deposit when dry. Although silica gel is non-abrasive, it can pick up solid particles in the coolant and become a gritty, abrasive deposit that can cause excessive wear of water pump seals and other cooling system components.

If it is suspected that a coach cooling system has a gelling problem (indicated by engine overheating or coach underheating), first try to remove the gel in its "wet" condition. Use an alkaline cleaner (Nalprep 2001 or equivalent) as directed by the manufacturer, so that the silica-gel is not allowed to dry. If using the cleaner once does not correct it, repeat the procedure. If available, ultrasonics is another process that can be used to remove the gel without damage to cooling system components.

If silica-gel has been allowed to dry inside a cooling system component, removing the gel becomes more difficult. The gel tends to form in low areas of the cooling system, e.g., radiator bottom tank or areas within the engine oil cooler. If gel can be reached for mechanical cleaning (removal of radiator bottom tank or "rodding" out a radiator core), then that method can be used.

Finally, dried silica-gel may be removed from a cooling system component by removing that component from the coach and agitating it in a caustic solution. Extreme care must be taken when handling such caustic solutions. Safety glasses and protective gloves should be worn. **Do not flush engine cooling system with caustic solutions because damage can occur to both metallic and non-metallic components.**

The following recommendations are made to prevent silica-gel formation:

- Use antifreeze that meets GM-6038M formulation which limits the amount of silicate to 0.1% maximum.
- Use antifreeze solutions at the concentration required for freeze protection in your operational area, but **do not** use more than 67% antifreeze or less than 30% antifreeze.
- Never use 100% antifreeze for make-up coolant. Mix the make-up solution at the same concentration as the original fill.
- Use corrosion inhibitor supplements only as required to maintain proper system protection. The system should be tested to determine the need for additional inhibitor. Test kits and test strips are commercially available to check engine coolant for corrosion inhibitor strength level. Coolant should be tested to determine the need for corrosion inhibitor supplements and the amount required. Do not use one manufacturer's test to measure the inhibitor strength level of another manufacturer's product. Always follow the manufacturer's recommended test procedures. New additives, Nalcool 3000 with stabile-aid and

Fleetguard DCA4, have been developed to help prevent silicate dropout and this may be added to the system when need arises.

- As much as possible, avoid using what can be considered “hard” water when mixing with antifreeze.
- Phosphate can drop out of solution and crystallize on heat transfer surfaces and water pump seal faces. Phosphate may be removed by flushing system with water to re-dissolve crystals.

COOLANT

Coolant solutions must meet the following basic requirements:

1. Provide for adequate heat transfer.
2. Provide a corrosion-resistant environment within the cooling system. Most generic antifreezes will require addition inhibitor packages.
3. Prevent formation of scale or sludge deposits in the cooling system.
4. Be compatible with cooling system hose and seal materials.
5. Provide adequate freeze protection during cold weather operation and boil-over protection in hot weather.

The first four requirements are satisfied by combining a suitable water with reliable inhibitors. When freeze protection is required, a solution of suitable water and antifreeze containing adequate inhibitors will provide a satisfactory coolant. Mix antifreeze/water makeup solutions at the proper concentration before adding to the cooling system. This should prevent over- or under-coolant concentration problems. Coolant properly maintained and protected with supplement inhibitors can be operated up to two years, 200,000 miles, or 4000 hours

NOTE: mix and fill system with the recommended ethylene glycol-base antifreeze and water solution at the required concentration. Add the required cooling system inhibitors (if needed). Failure to use and maintain antifreeze, water and inhibitor coolant mixture at sufficient concentration levels can result in damage to the cooling system and its related components. Conversely, the overconcentration of antifreeze and/or inhibitor can result in poor heat transfer, leading to engine overheat, additive dropout, or both.

Although not recommended, plain water with an approved inhibitor of strength may be used as a coolant where temperatures do not reach below 32°F (0°C). In colder regions, antifreeze must be used.

Always maintain coolant at recommended levels. Aerated coolant and/or an air-bound water pump can be catastrophic to engine life. After filling a cooling system, run engine until thermostats open and top off to recommended full level. Overfilling a cooling system can result in unnecessary loss of coolant and, in some rare cases, engine overcooling, especially during cold weather operation. Reinstall fill/pressure cap. Inspect all components that make up the cooling system for leakage and make necessary repairs at this time.

NOTE: Do not use sealer additives in the cooling system. The presence of the gumming and gelling material in stop-leak additives could cause plugging in the cooling passages, which will adversely affected the cooling system.

⚠ CAUTION ⚠

Never open fill cap while coolant is hot. Open cap slowly and only when coolant is at ambient conditions. A sudden release of pressure from a heated cooling system can result in possible personal injury form the expulsion of hot coolant.

The total amount of chemicals in the coolant can be controlled to desirable levels by using the referenced antifreezes at the needed freeze protection concentration adding DDC-selected inhibitors and water that meets DDC requirements. A list of available antifreeze/inhibitor products that meet GM-6038M or DDC requirements are shown below:

Company	**Product**
DDC	Powercool
Caterpillar	Long-Life
Texaco (1)	2055 (was JC-04)
BASF Wyandotte (1)	241-7
International Harvester (1)(5)	I.H. Antifreeze
Old World Trading Co. (1)	Full Force Advance
Northern Petro-Chemical (2)	All Weather (NPC 220)
Dow Chemical Canada (3)	731
Houston Chemical Corp. (4)	Security (701)
Nalco Chemical Co.	NALCOOL 2000-Liquid
Nalco Chemical Co.	NALCOOL 3000-Liquid
Penray Company .	NALCOOL 3000-Liquid
Nalco Chemical Co.	NALCOOL 2001-Cleaner
Nalco Chemical Co.	Nalco 2015 Twin Pac-Dry Chemical Cleaner/Conditioner

SUMMARY OF COOLANT REQUIREMENTS

1. Always use recommended antifreeze, inhibitor and water at proper concentration levels.
2. Use only ethylene glycol antifreeze (low silicate formulation) meeting the performance specification of GM 6038-M (GM 1899-M) or ASTM D 4985 formulation.
3. Use an antifreeze solution year-round for freeze and boil-over protection. Seasonal changing of coolant from an antifreeze solution to an inhibitor/water solution is not recommended.
4. Pre-mix antifreeze makeup solutions at the proper concentration before adding to the cooling system.
5. Maintain the prescribed inhibitor strength levels as required. Test at each oil change interval and add inhibitor as needed. Do not use another manufacturer's test kit to measure the inhibitor strength of DDC-selected products.
6. Follow Detroit Diesel's recommendation on inhibitor usage and handling. Do not mix different base inhibitor packages.
7. Use only non-chromate inhibitors.
8. Supplemental coolant inhibitors must be added to all Series 60, and 92 engines after initial fill and must be maintained.
9. Change coolant filters at regular service intervals.
10. DO NOT USE THE FOLLOWING
    - Soluble oil
    - Chromate inhibitor
    - Methoxy propanol-base antifreeze
    - Methyl alcohol-base antifreeze
    - Sealer additives or antifreezes containing sealer additives.
11. Use only water meeting specifications found in Tables 1 and 2 in Figure 5. Use of distilled water is ideal.
12. Always maintain proper coolant level.
13. A cooling system properly maintained and protected with antifreeze and supplemental inhibitors can be operated up to two years, 200,000 miles, or 4000 hours, whichever comes first. At this interval the coolant must be drained, discarded in a safe manner, and the cooling system cleaned thoroughly. Refill cooling system with a recommended water/antifreeze/inhibitor mixture at appropriate concentration level.

NOTE: All of these coolant formulas and/or additives are enhanced when used in conjunction with a cooling system contaminants catch filter similar to the optional Perry water filter assembly.

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 7

ELECTRICAL SYSTEM

This section consists of ten primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The primary subsections are:

A - Electrical Systems
B - Alternator
C - Voltage Regulator
D - 42MT Starter (Electric)
E - Speedometer
F - Alarms and Signals
G - Batteries
H - Sound and Video Systems
I - Interior and Exterior Lighting
J - Electrical Schematics

SECTION 7A

ELECTRICAL SYSTEMS

CONTENTS OF THIS SECTION

SUBJECT **PAGE**
General Description 7A-1
Components 7A-2
Maintenance 7A-5

GENERAL DESCRIPTION

The coach uses a 12V and 24V negative ground electrical system (i.e., the negative battery terminals connect directly to the coach frame). Batteries supply power to start the engine and the direct drive or belt driven 24V alternator recharges the batteries and provides power to all other coach electrical devices while running. The batteries are located inside the battery compartment midway along the RH side of coach.

All electrical circuits are protected by circuit breakers, fuses and/or fusible links. A fusible link type 12V/24V main battery disconnect switch is provided to cut power to all electrical devices. Main power harnesses are located within the center tunnel, and interconnects the battery compartment with junction boxes and the starter.

NOTE: All electrical connections must be kept clean and tight. Inspect all wiring connections at regular intervals. Loose or corroded connections could cause a discharged battery, difficult starting, dim lights, and improper functioning of other electrical equipment.

The electrical system incorporates three main junction boxes and one remote engine control box. These boxes contain most of the circuit control and protection devices (i.e., relays, solenoids, breakers) and terminal studs for electrical component interconnection.

All exterior running lights are 12 volt, as are the interior aisle seat lights, lights on the front end of the parcel racks, the rear blue bench seat light, lavatory light and a few instrument panel lights. Twenty-four volt power is used in most all other applications.

⚠ CAUTION ⚠

Due to the close proximity of electrical harnesses to the aisle floorboard, do not drill any holes in the center tunnel area. This area is 15 inches wide and runs immediately under the coach center aisle for the full length of the coach.

The following information pertaining to welding should be read and understood before beginning any welding procedure or process. The following prohibitions and requirements must be followed before welding on a coach.

1. Welding must be done only by a qualified and experienced person.

2. Adequate ground contacts and barriers must be positioned as close as possible to the weld area and as required to protect components (wiring, brake lines, hydraulic lines, etc.) from damage due to heat, contact by weld splatter, arcing or other potentially damaging events associated with welding.

3. On any coach, turn battery switch to “OFF.”

4. Coaches equipped with a battery equalizer must first disconnect the ground at the equalizer, and then disconnect the battery leads.

5. If coach has ATEC or DDEC, remove the ATEC and DDEC power control fuses.

6. Any applicable welding instructions or prohibitions given by a procedure must also be heeded.

The coach starting and charging circuit is described in detailed below. This circuit is a typical example of how the electrical components are arranged to perform a specific operation, while protecting the coach components from potential damage. Refer to schematic 7L-13-1708 in Section 7J of this manual while reviewing the text.

When the master run switch is positioned “ON” it energizes the master control relay with voltage from the front junction box buss bar. This relay enables both front and rear engine start switches. When either of the engine start switches are actuated, voltage is sent through the triple protection device (circuit #3) and out to the neutral relay (circuit #6). The neutral relay’s coil receives voltage from rear junction box stud 24. If the neutral switch is closed (grounded) the relay should energize.

NOTE: The triple protection device (circuit #8) receives power from rear junction box stud 25. The mechanically actuated neutral switch is present on manual and HT-740 transmissions. On ATEC transmissions a ground is provided to the relay through circuit #231.

When closed the neutral relay sends voltage to the starter solenoid and energizes it. When this solenoid is energized, voltage from a rear junction box stud flows to the starter motor solenoid and energizes it. When energized, it allows high amperage current to flow directly from the battery to the starter motor through the disconnect switch.

During the starting operation voltage from the triple protection device (circuit #9) illuminates the “STARTER ALERT” tell-tale lamp. This lamp will remain lit until the engine starts and the triple protection device (circuit #5) senses the alternator’s R1 circuit signal.

NOTE: When the triple protection device senses alternator R1 signal, voltage to the starter solenoid drops out and starter is disengaged automatically. This automatic function of the device prevents damage to the starter if start switch is not released.

After starting, the alternator’s R1 circuit provides power to the discharge blower relay’s coil. However, this relay does not energize until the normally-closed rear junction box air pressure switch opens and goes to ground. When this relay is energized, it enables heating and air conditioning systems.

NOTE: When the air pressure switch is open, it’s low pressure warning circuit is de-energized.

During engine start the field relay’s coil is energized from rear junction box stud 25. The field relay attains ground through the triple protection device (circuit #7). This allows voltage to flow to the regulator and out to the field coil of the alternator. This causes the alternator to produce the correct 27.2 volts needed for recharging the batteries or providing power to other coach electrical components.

NOTE: Circuits #1 and #2 of the triple protection device are grounded.

Batteries are recharged by the alternator BAT circuit, which sends 24 volt power back through to the engine cradle stud. The recharging voltage travels from the stud back to the batteries through the disconnect switch. A Vanner equalizer is also installed in this circuit to assure proper recharging of both batteries at approximately 8 amps.

If after starting, the triple protection device detects an over-voltage condition (above 31.5 volts), the device should drop ground to the field relay (circuit #7). This would cause loss of current to the regulator and subsequent loss of signal to the alternator’s field coil.

Voltage through the R1 circuit is stops, which would de-energize the discharge blower relay. When the relay is de-energized (open), it allows voltage from the rear junction box master circuit buss bar to illuminate the front/rear “NOT GEN” tell-tale lamps.

COMPONENTS

FRONT JUNCTION BOX

The front junction box is the largest of the three main boxes. This box is located below the driver’s window and contains a 100 stud terminal block, a number of circuit breakers, relays and solenoids associated with engine function, HVAC, lights, horn, etc. It contains all audible warning buzzers or alarms and audio equipment for public address systems. All instrument panel functions are routed through this junction box (Figure 1).

A/C DDEC & ATEC JUNCTION BOX

The A/C DDEC & ATEC junction box is located on the ceiling on the #1 LH baggage compartment. This box contains a number of main circuit breakers and relays associated with HVAC systems. The ATEC and DDEC diagnostic plugs are routed through this junction box and the ATEC ECU is mounted here (Figure 2).

NOTE: The air conditioning junction box was located in the #3 baggage bay on units prior to 45073, and is now located in the #1 baggage bay.

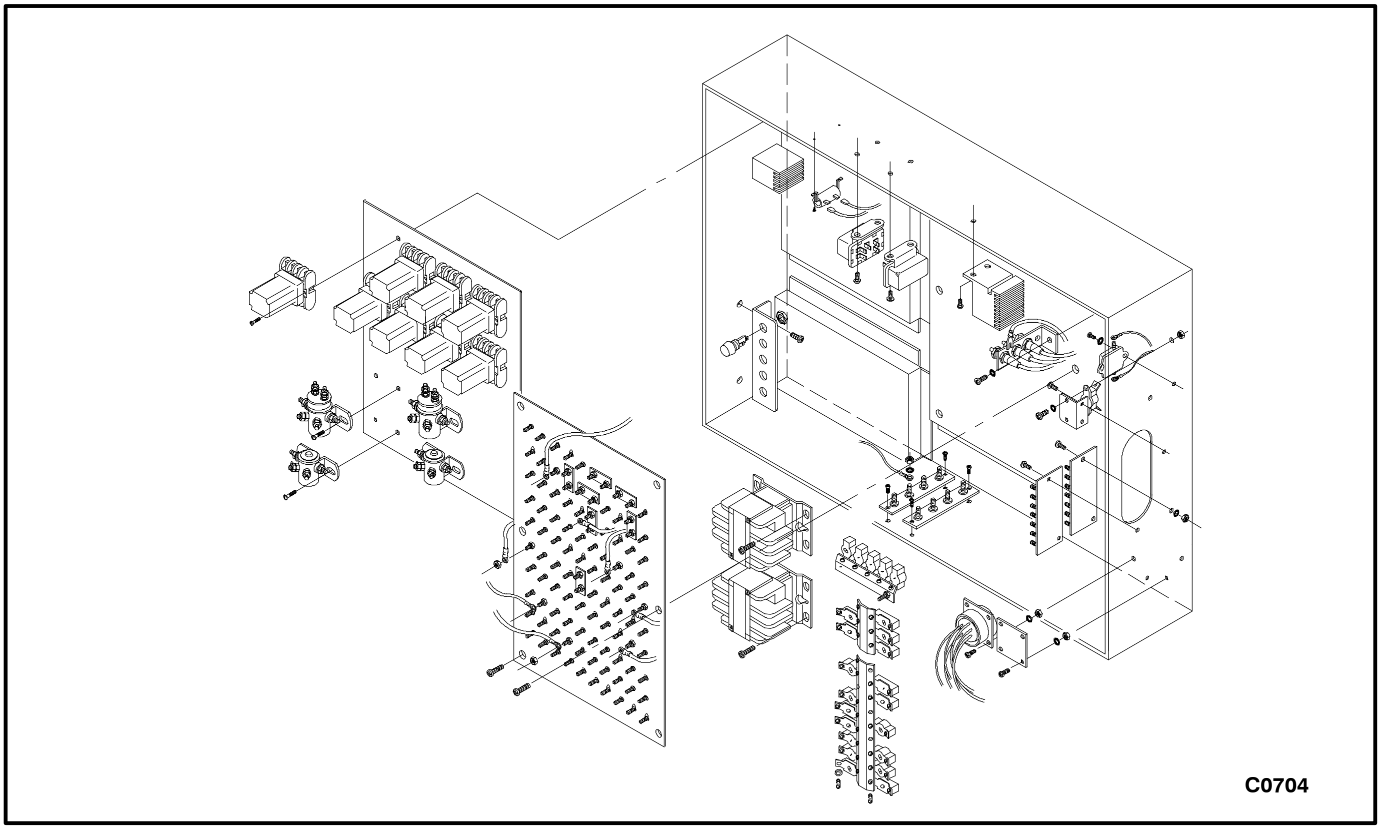


Figure 1. Front Junction Box

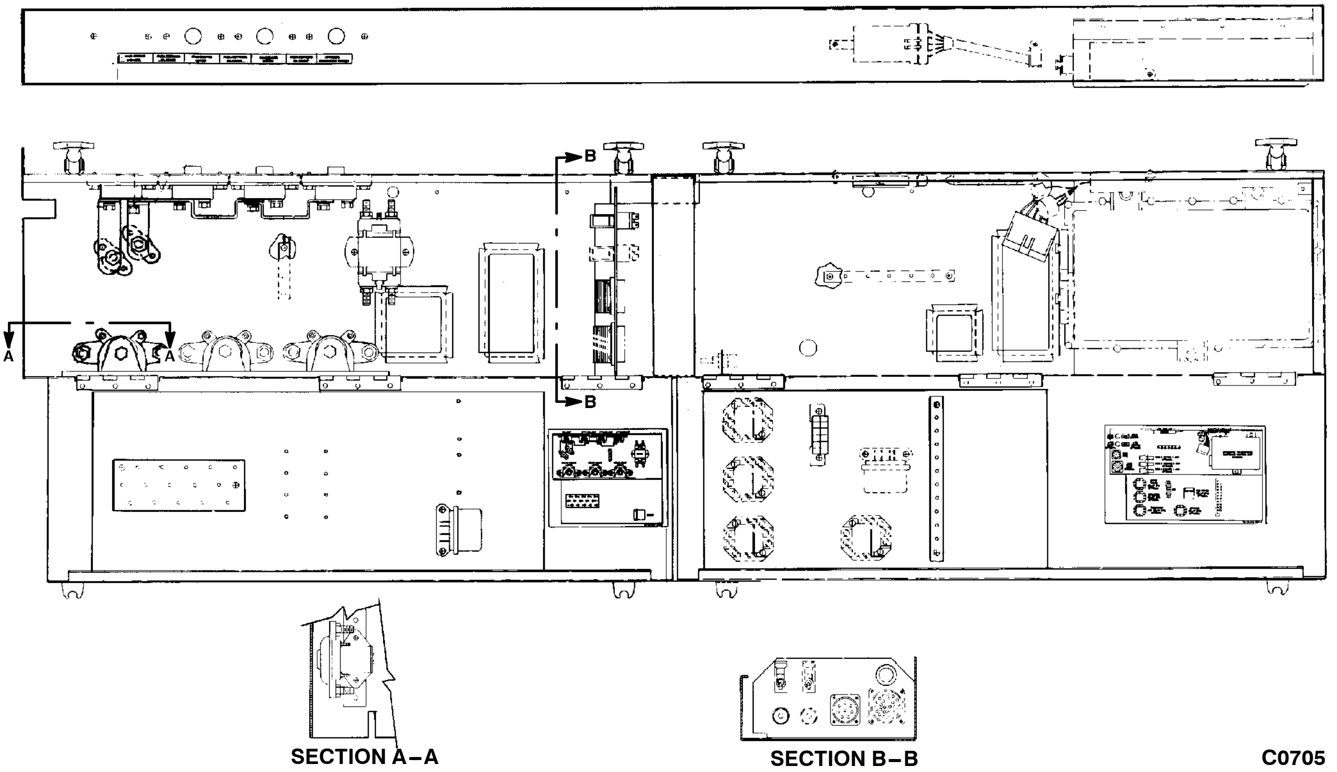

B
B
A
A
SECTION A−A
SECTION B−B
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Figure 2. A/C DDEC/ATEC Junction Box

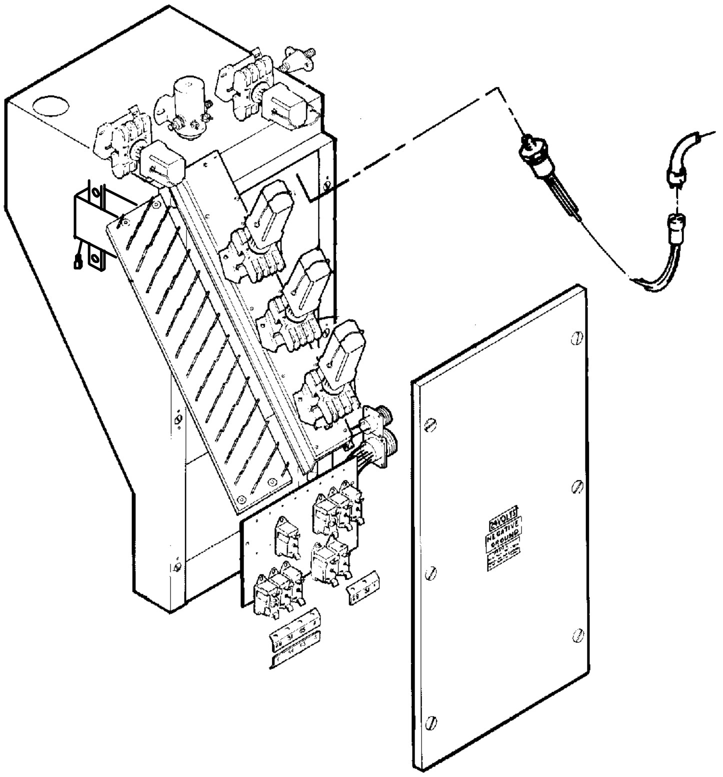

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Figure 3. Rear Junction Box

REAR JUNCTION BOX

The rear junction box is the smallest of the three main boxes. This box is located at the front LH rear side service door opening and contains a 65 stud terminal block, a number of circuit breakers and relays associated with engine function, starting and charging circuit, air system, remote box etc. All ATEC and DDEC circuits are routed through this junction box (Figure 3).

REMOTE ENGINE CONTROL BOX

This box is located on the LH front ceiling in the engine compartment. The box contains remote engine start controls and coolant recovery controls.

WTEC CONTROL BOX

A separate WTEC control box is now located in the #1 LH baggage bay mounted to the rear wall below the harness channel. This box contains the WTEC transmission ECU, Vehicle Interface Module (VIM) and DDL diagnostic plug.

NOTE: Effective with unit #49595 the WTEC ECU was changed from a 12 volt to a 24 volt powered system.

CIRCUIT PROTECTION

Circuit Breakers

The front junction box's main (105 amp) circuit breaker is automatically resetting and located along with the condenser fan and evaporator blower motor's (105 amp) manually resetting breakers in the air conditioning junction box.

The battery equalizer circuit also features (105 amp) manually resetting circuit breaker protection, and is located in the battery compartment The optional in-station lighting (30 amp) manually resetting circuit breakers are located in the front service compartment (Figure 4).

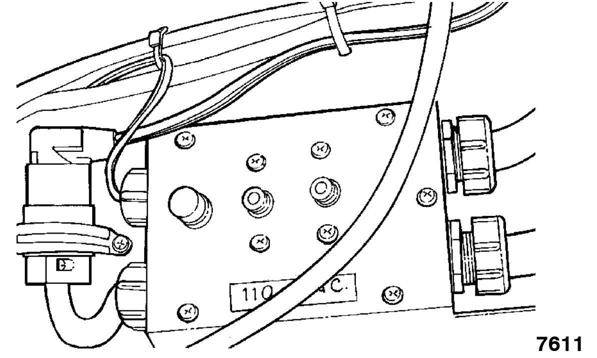

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Figure 4. In-Station Lighting Circuit Breakers

Smaller circuit breakers of the self-resetting type are located in the front and rear junction boxes. When one of these circuit breakers opens due to a shorted circuit, it will automatically reset itself when the breaker element cools. As long as the short exists, the breaker will continue to open and close intermittently. In this case, turn the defective circuit off until the cause can be located and corrected.

Fuses

Some components of the coach are protected by fuse. Among these are the DDEC and ATEC electronic control modules and the Webasto auxiliary heater and timer. The fuses for these components are located in the battery compartment. Some components of the coach are protected by using a fusible link device. The most common fusible link devices are the buss bars found in the junction boxes. The 12/24 volt main disconnect switch act as a fusible link device for starter circuit protection.

SWITCH LOGICS

Relays & Solenoids

Relays and solenoids are used to automatically energize or de-energize a circuit from a remote location. The relay or solenoid draws a very low current to energize its coil. Once the coil is energized, it develops a magnetic field which will pull a switch contact closed or open to either energize or de-energize a given component.

Because the control current required for the coil is very low, the relay or solenoid allows a remote station (e.g. driver's switch panel) to control a high energy circuit without running great lengths of costly high capacity cable. With the use of a relay or solenoid, the need for high amperage switches and heavy connectors is eliminated.

The coach uses control relays or solenoids for the low and high note horns, headlamps, discharge and blower cut-ins, engine stop, starter, condenser and evaporator motor solenoids, driver's defroster, alternator field, neutral relay, window and indirect lights, etc.

BATTERIES

Electrical power is supplied by two SAE type 8D 12 volt wet cell batteries connected in series and rated at approximately 1160 amps each. Fully charged batteries could supply over 1800 amps of power to the starter during cold weather start conditions. The batteries perform four major functions in coach operation:

A. Provide a source of electrical power to crank the engine when starting.

B. Stabilize coach electrical system voltage as various accessories are switched on and off.

C. For a limited time, furnish electrical current when the demands of the electrical equipment exceed the output capabilities of the alternator.

D. Provide a limited source of electrical power for connected accessories when the engine is not operating.

For more information on the batteries refer to Section 7G.

ALTERNATOR

Both the gear or belt driven 50-DN Delco oil-cooled alternators provide 27.2 volt power (maximum) at approximately 270 amps. Voltage is controlled by the alternator's field coil and the voltage regulator. The alternator perform two major functions in coach operation:

A. Provide a power source to operate electrical coach equipment after the engine has started.

B. To recharge the batteries through the Vanner equalizer circuit.

For more information on the alternator refer to Section 7B.

MAINTENANCE

CIRCUIT TEST EQUIPMENT

Test Lights

Either a 12- or 24-volt test light with two leads may be used to check voltage or to check for a short to ground. A battery-powered test light with two leads wired in series may be used to check continuity in the circuit and to check for ground.

⚠ **CAUTION** ⚠

Make certain the battery switch is "OFF" when testing, to prevent damage to the circuit and test light.

Voltmeter

A DC voltmeter is used to check the DC voltage to ground. The negative lead is connected to the ground side of a circuit and the positive lead is connected to the battery side of the circuit.

Ohmmeter

An ohmmeter may be used to measure resistance between two points in a circuit.

⚠ **CAUTION** ⚠

An ohmmeter must be used only on de-energized circuits. An energized circuit may cause meter damage or inaccurate resistance measurements.

Jumper Wire

A jumper wire may be used in troubleshooting to bypass certain components or circuit segments where an open is suspected. A jumper is a length of wire with clips or terminals used to connect two points of a circuit.

⚠ WARNING ⚠

Do not use a jumper wire to bypass high-resistance loads. this would short to ground and may cause damage to the circuit and/or injury to maintenance personnel.

TROUBLESHOOTING PROCEDURES

For an accurate diagnosis of any electrical problem, it is necessary to follow a step-by-step troubleshooting procedure. First, verify the problem by operating the suspected circuit. Once the problem area is verified, then refer to the wiring schematic of the problem circuit.

Next, trace the circuit and redraw it if necessary. This will help to identify the connections, splices, grounds and components in the troubled circuit. After tracing the circuit, systematically test for faulty components, connections, or grounds to isolate the problem.

When the problem is isolated and a particular element of the circuit is determined to be the cause of the problem, make the necessary repair and operate the circuit to verify the repair.

Open Circuits

Many electrical system failures are caused by an open circuit. An open circuit is one in which power flow stops because of an interrupted or incomplete circuit path. An open circuit is caused by an improper ground, a broken connector, poor terminal contact, a loose or broken wire, an open or faulty component, or a circuit breaker or fuse opened by a short or overload.

Testing to isolate an open circuit can be accomplished by using a jumper wire to bypass a suspected open element. If the circuit operates with the jumper in place when power is applied, then the open is in the segment of the circuit bypassed.

Another procedure to pinpoint an open in a circuit is to test for power along the circuit, using a test light. If the test light indicates power at one point, then is moved to another where it does not indicate power, the circuit is open between the two points.

A third test, using a self-powered test light, can be conducted to detect an open in a component. First disconnect the component from the circuit, then connect the leads of the self-powered test light to the load. If the test light does not light, an open exists in the component.

Short Circuits

Many electrical system problems are caused by short circuits. A short circuit is a power circuit that has been grounded before it completes the intended operating circuit.

To diagnose a short to ground, use a self-powered test light to test for continuity to ground. First, disconnect the circuit from power and ground. Next, connect the test light between the circuit and ground; the test light will glow if the circuit is shorted to ground. To isolate the short, open elements of the circuit one at a time until the light goes out. The short is in the last element opened or in the segment of the circuit beyond the last element opened. To pinpoint the short, test each element of the isolated segment.

A tripped circuit breaker or a blown fuse usually indicates a short to ground or overloaded circuit. Use a test light to isolate the short. First, turn “OFF” all elements of the circuit receiving power through the circuit breaker or fuse and disconnect all loads. Turn “ON” the power to the fuse, then connect one lead of the test light to the power supply side of the circuit protector and the other lead to ground; the light should indicate power. Next, disconnect the ground lead of the test light and connect it to the load side of the fuse. If the light is “OFF”, the short is in the disconnected equipment. If the light is “ON”, the short is in the wiring. To pinpoint the short, disconnect circuit elements one at a time until the test light goes “OFF”. The short will be in the segment connecting the last element.

ELECTRICAL SCHEMATICS

Wiring diagrams and schematics for the electrical systems are shown in sub-section 7J. A careful study of the wiring diagrams should be made to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point-to-point check can be made with the aid of the applicable wiring diagrams. Any circuit may be tested for continuity or shorts with a suitable volt-ohmmeter.

SECTION 7B

ALTERNATOR

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

Both the gear driven and belt driven 50DN alternators are oil cooled, brushless and self-rectifying units, in which all current carrying members, windings, diodes, and field coils are stationary. The only moving component is the rotor. The 8V-92 alternator installation can be reached through the left side rear engine compartment door and the access door under the rear cross seat (Figure 1). The Series 60, Cat & Cummins alternator installations can be reached through the LH/RH rear motor access doors.

The oil-cooled alternator is a totally enclosed unit, cooled and lubricated by engine oil. The oil inlet is on the diode end cover. The oil drains back into the engine crankcase internally through the drive end frame and the oil drain tube. The alternator should never be operated with the oil supply line disconnected. A continuous flow of engine oil flows through the alternator to lubricate the bearings and cool the assembly.

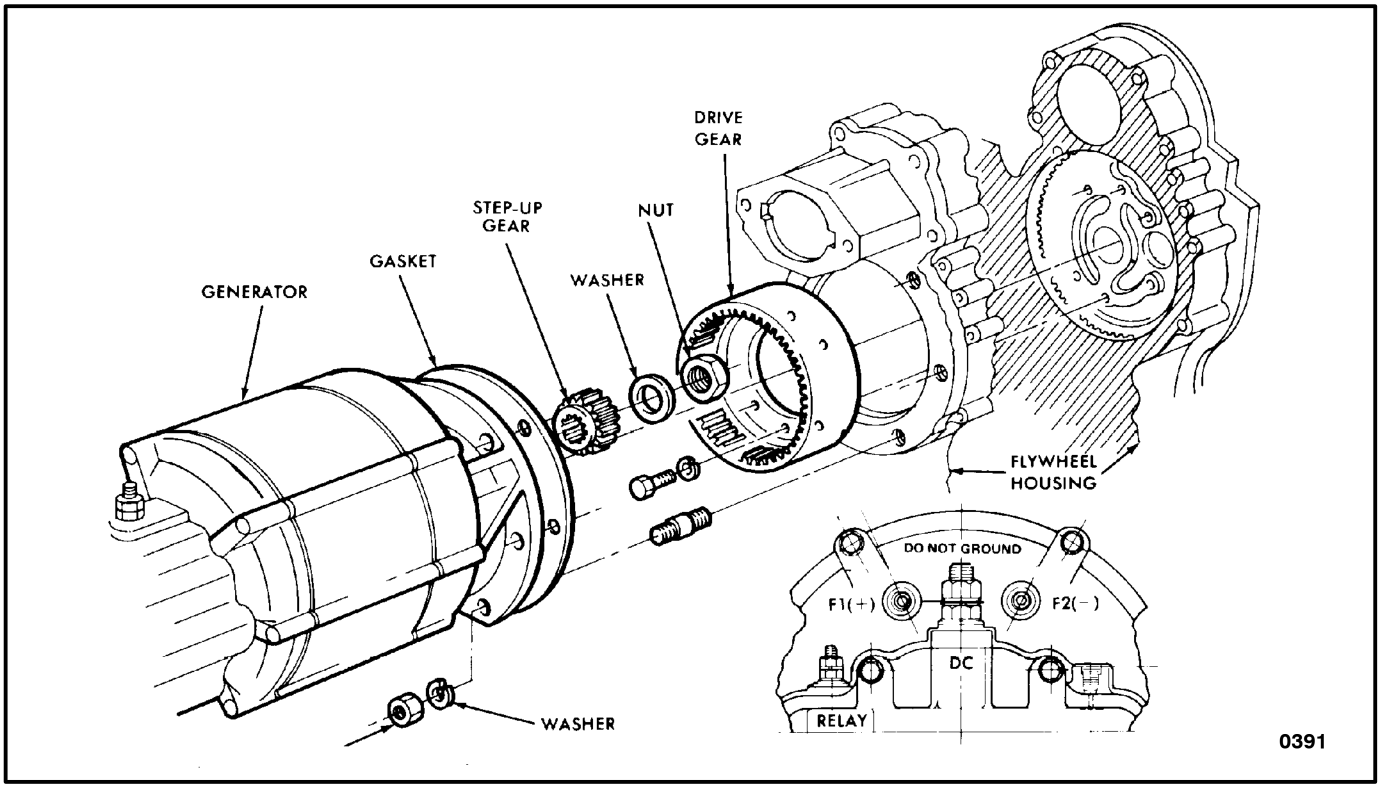


Figure 1. 8V-92 Alternator Installation

OPERATION

The following general procedures are important in protecting the alternator, voltage regulator and other electrical or electronic systems on the coach.

1. After installing a new or rebuilt alternator, make certain that all wiring to the alternator and to the voltage regulator is completely installed before attempting engine start-up.
2. Do not remove any wires or cables from the alternator or from the voltage regulator while the battery disconnect switch is "ON."
3. Do not perform any welding operation on the coach without following the steps listed in the "WELDING CAUTION" in the Introduction to this manual.

A series of steps to be taken to protect the alternator from damage when initially starting a newly installed engine are listed below. When a new or rebuilt engine is first started, it may stall due to lack of prime in the fuel system. When the engine stalls, built-up compression may induce roll back in the engine causing the alternator to reverse direction and thereby produce a negative voltage spike. This negative spike could burn out a transistor in the voltage regulator making it ineffective in protecting the alternator.

MAINTENANCE

TESTING PROCEDURES

The alternator is controlled by a field relay and voltage regulator. There are three components in the alternator which require electrical checks; the field winding, the six diodes, and the stator winding (Figure 2).

⚠ CAUTION ⚠

The alternator is designed for use only on a negative ground system. If a positive ground battery is connected to the alternator, the alternator and wiring harness will be instantly destroyed. Always ensure that the alternator and batteries are negative ground. The alternator will not reverse to accept inverse polarity. Do not ground or short across any of the alternator or regulator terminals. Before checking the alternator turn "OFF" the battery disconnect switch.

Field Windings

The field winding may be checked for shorts and opens with an ohmmeter. To check the field winding, connect the ohmmeter from the field terminal to ground. The normal resistance value is 3.0-3.3 ohms at 80°F (27°C).

An alternate method of checking is to place a battery, of specified voltage, and an ammeter in series with the field winding. The current should register 7.2-8.3 amperes at 24 volts.

A defective field can be replaced by removing the end frame on which the field terminal is located and then removing the four field coil mounting screws. See the section entitled Disassembly for a detailed procedure.

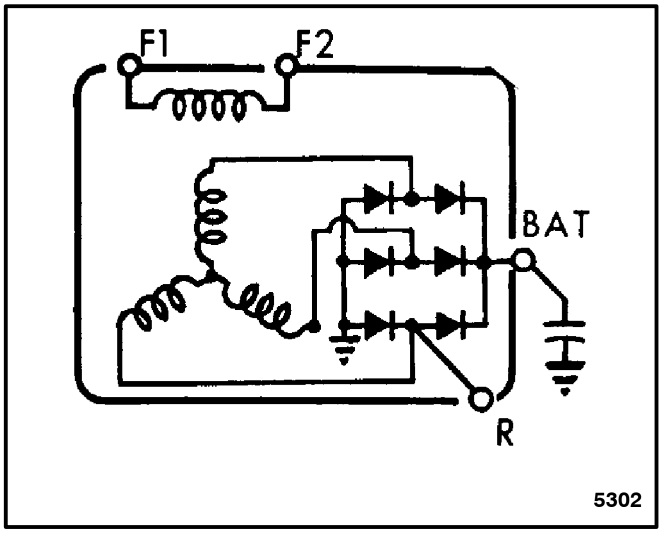


Figure 2. Alternator Wiring Diagram

Diodes

Each diode may be checked for shorts and opens as follows:

1. Check to ensure the battery is disconnected.
2. Remove the pipe plug from underneath the end housing to drain the oil in the rectifier engine oil supply.
3. Remove the screws attaching the diode cover to the end housing.
4. Detach the diode leads from the D.C. terminal and relay R1 terminal, then disconnect the end frame mounted diode leads from the supports.

NOTE: A scale type ohmmeter with 1-1/2-volt cell should be used. Select a scale on which the 300 ohm value lies within the middle third of the scale. Many digital ohmmeters cannot be used to check diodes.

To check the three diodes mounted in the diode supports for shorts or opens, connect the ohmmeter to each diode lead and to each support as shown in (Figure 3)"A", "B" & "C". Reverse the ohmmeter lead connections to the same diode to obtain two readings.

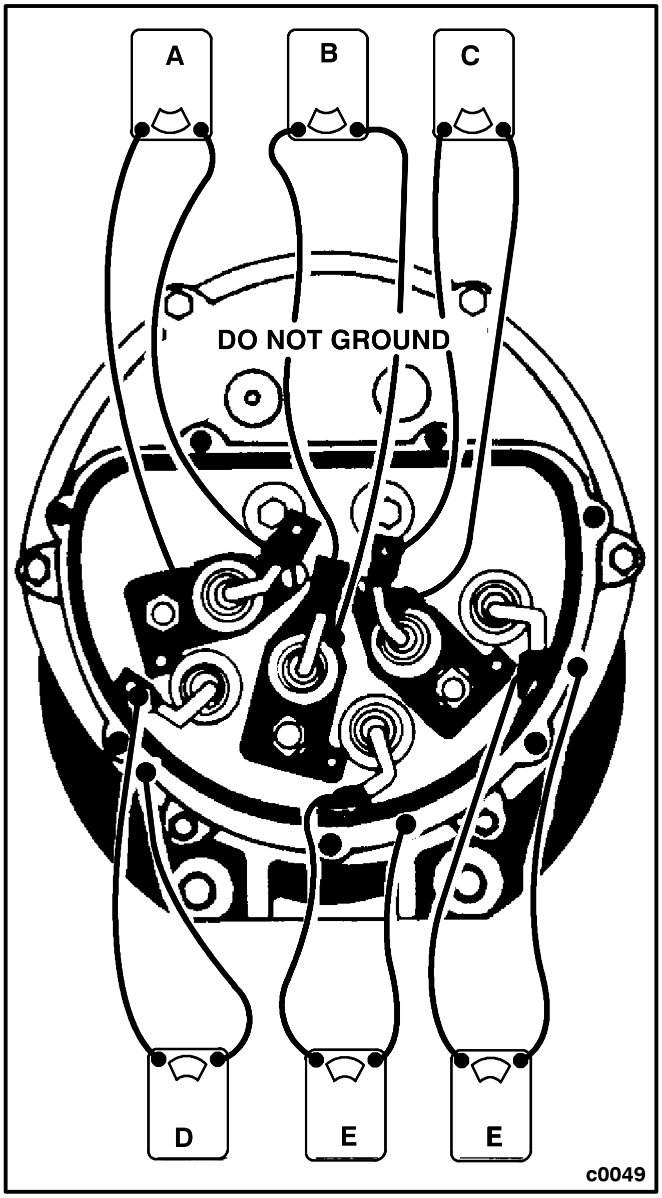


Figure 3. Checking Diodes

To check the three diodes mounted in the end frame for shorts or opens, connect the ohmmeter to each diode lead and the end frame as shown in (Figure 3) “D”, “E” & “F“. Reverse the ohmmeter lead connections to the same diode to obtain two readings.

Ohmmeter readings readings may vary considerably when checking diodes, but if both readings are below 300 ohms, or if both readings are above 300 ohms, the diode most likely is defective and should be replaced. A good diode will give one high and one low reading.

5. After making the check on the diodes reattach all leads, and reverse steps #1 through #3.

NOTE: When reinstalling diodes, tighten to 9-11 foot-pounds (12-15 N·m) torque. Restake next to the threads in an arbor press with an 1/8 inch (3.2 mm) round punch. Press the punch with gradual pressure; Do not strike as the shock may damage the diodes.

Stator Windings

The stator windings may be checked for opens and shorts with an ohmmeter as follows (Figure 4). Connect the ohmmeter leads to two pairs of diode supports as shown in (Figure 4) “A” & “B”. The ohmmeter should show a low resistance. If a high or infinite resistance is measured in either one or both checks, the stator windings are open.

NOTE: Effective with unit 46158, alternators will be provided with flexible stator winding leads.

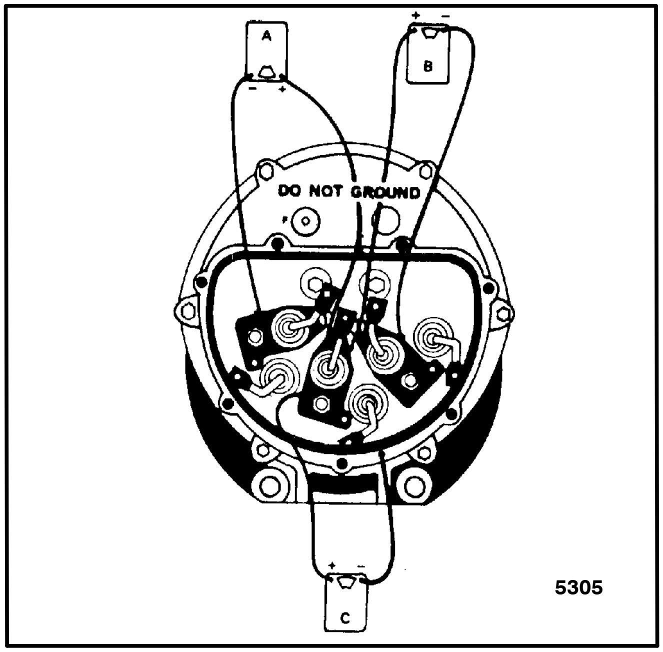


Figure 4. Checking Stator Windings

Output Check

When removed from the engine, the alternator may be checked on a test bench without circulating oil, providing the output is limited to 100 amperes or less. The alternator may be checked without circulating oil at outputs exceeding 100 amperes as long as the period of operation is limited to less than 15 seconds.

⚠ CAUTION ⚠

Operating the alternator at outputs greater than 100 amperes for periods exceeding 15 seconds without circulating oil will cause the alternator to overheat, resulting in damage to the winding and diodes.

DRIVE BELTS

The ribbed poly-V drive belts are very sensitive to tensioning. Without a tensioning gauge and a proper measurement, the belt's tension will probably be incorrect. A Burroughs belt tension gauge (Kent-Moore P/N J41251-B or equivalent) is recommended by MCI and the engine manufacturer.

NOTE: Effective with unit 47852, new drive belts of hypalon material were installed on Detroit Diesel engines (Reference: P/N 8L-27-129). These belts require a slightly different adjustment.

Inspection

1. Set park brake, and turn off the battery at the disconnect switch.
2. Clean any dirt and oil from the alternator drive belt.
3. Make measurements of the belt tension midway between the drive pulley and the upper idler, or between the upper idler pulley and the alternator pulley.
4. Fully depress the plunger on the gauge and install onto belt. The belt must be positioned over the hook and under the leg pads to attain a reading.

NOTE: The entire belt width must be supported by the hook and covered by the leg pads. Support legs on gauge should not contact pulleys or any other engine components while making measurements. Rap belt several times with clenched fist to equally distribute the tension in belt during measurement.

5. Release plunger on the gauge handle and read the tension on the face of the gauge. Repeat the measurement several times to ensure accuracy.

Tensioning (Series 60 & Caterpillar)

1. Set park brake, and turn off the battery at the disconnect switch.
2. Unloosen belt tensioning pulley mechanism's locking bolts (2) and adjust the jack screw to the desired tension.
3. New belts should be tensioned as follows:
   A. Old Detroit Diesel - set @ 300 pounds
   B. New Detroit Diesel - set @ 350 pounds
   C. New Caterpillar - set @ 200 pounds

NOTE: Effective with unit 48489, Caterpillar C-10 engines will be equipped with the jack screw style tensioning mechanism. The drive belts used in this arrangement are different from the 3176B belts (Reference: P/N 8L-27-128)

NOTE: New belts lose tension rapidly during the first few minutes of operation, and require retensioning after a 10 minute run-in and 15 minute cool-down period.

4. If after run-in period the belt tension is less than 200 pounds, retension as follows:
   A. Old Detroit Diesel - reset @ 200 pounds.
   B. New Detroit Diesel - reset @ 250 pounds.
   C. New Caterpillar - reset @ 200 pounds

NOTE: In-service good condition belts should also be reset to these ratings.

5. Retighten locking bolts to 75-93 ft.lbs. (101-126 N•m), and recheck tension before removing belt tension gauge.

REMOVAL (BELT DRIVEN)

1. Turn off the battery at the disconnect switch.
2. Disconnect electrical wiring at diode end frame.
3. Disconnect engine oil supply and return lines.

NOTE: Leave alternator oil distributor tube attached, as this is provided with the replacement alternator.

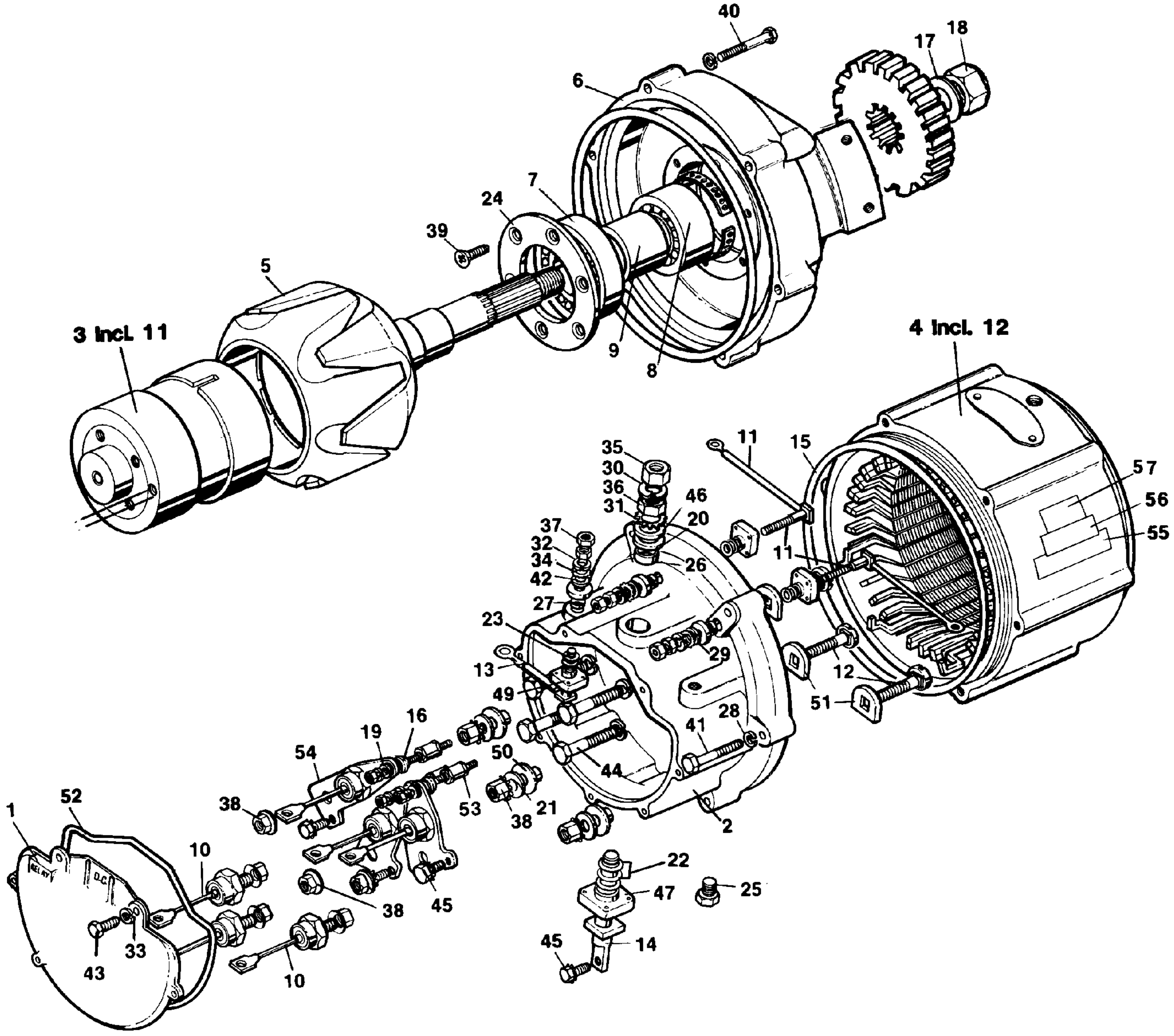
4. To remove drive belt, retract jack screw tensioning mechanism (Series 60 & Caterpillar C-10), or rotate spring tensioning arm pulley mechanism away from belt (Cummins & Caterpillar 3176B).
5. Unfasten and remove upper alternator support bracket (Caterpillar & Cummins).
6. Unfasten and remove the four mounting bolts and lift alternator off mounting bracket.

REMOVAL (DIRECT DRIVE)

1. Turn off the battery at the disconnect switch .
2. Disconnect electrical wiring at diode end frame.
3. Disconnect engine oil supply and return lines.

NOTE: Leave distributor tube connected to alternator end housings, as this is provided with the replacement alternator.

4. Remove the nuts and washers from the six (6) studs mounting the alternator. Pull alternator straight off mounting studs and adapter plate.
5. Remove the adapter plate by unfastening and removing the four upper adapter mounting bolts.



1. Cover - DE
2. Frame - DE
3. Field Assembly
4. Stator & Frame Assy
5. Rotor Assy
6. Frame - Drive End
7. Ball Bearing - Inner DE
8. Roller Bearing - Outer DE
9. Spacer - Bearing
10. Diode - In-Frame
11. Field Stud Terminal
12. Stator Stud Terminal
13. Relay Terminal and Lead Assy
14. DC Terminal Stud
15. Stator and DE O-Ring
16. Bracket Spacer
17. Shaft Washer
18. DE - Shaft Nut
19. Diode Support Bracket
20. DC Terminal Washer
21. Stator Terminal Washer
22. DC Terminal O-Ring
23. Field & Relay Terminal O-Ring
24. DE Rotor Plate
25. DE Frame Pipe Plug
26. DC Terminal Sleeve
27. Field and Relay Terminal Sleeve
28. DE Frame & Field Terminal Lockwasher
29. Field Mounting Lockwasher
30. DC Terminal Lockwasher
31. DC Terminal Lockwasher
32. Field Terminal Lockwasher
33. Field and Relay Lockwasher
34. Relay Terminal Lockwasher
35. DC Terminal Nut
36. DC Terminal Nut
37. Field & Relay Terminal Nut
38. Diode Mounting Nut
39. Bearing Retainer Plate Screw
40. DE Bearing Retainer Plate Screw (inner)
41. DE Frame & Cover Screw
42. DE Cover Washer
43. DE Cover Screw & Washer
44. Field Mounting Screw
45. Diode Lead Screw & Washer
46. DC Terminal Washer
47. DC Terminal Bushing Washer
48. Field Terminal Washer
49. Field & Relay Terminal Bushing Washer
50. Stator Terminal Washer
51. Stator Terminal Washer
52. Gasket
53. Diode Support Bracket Stud Assembly
54. Diode Support Bracket

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Figure 5. Alternator Components (Gear Drive)

DISASSEMBLY

1. Unfasten and remove the shaft hex nut and washer to remove drive gear (8V-92 Installations), or unfasten and remove the pulley hex nut and remove pulley from splined shaft (Caterpillar Cummins & Series 60 Installations).

2. Remove nuts and washers from DC terminal on diode end frame (Figure 5).

3. Separate the diode cover plate (3) from the diode end frame by removing mounting screws (1).

4. Remove the washer, nut and lockwasher attaching the diode supports to the end frame, the three screws (5) connecting the diode leads to the diode supports, and the three nuts (4) which attach the stator studs to the diode supports.

5. Separate the diode support assemblies from the diode end frame, and the three nuts (6) which connect the studs to the diode end frame.

6. Mark the position of the drive end frame and diode frame with respect to the stator assembly so that the parts can be reassembled in the same position.

7. Detach the diode end frame and field assembly from the stator assembly by removing the attaching screws (13).

8. Separate the field assembly from the diode end frame by removing the four attaching screws (11).

9. Separate the rotor assembly and drive end frame from the stator assembly by removing the attaching screws (25).

10. Press the rotor shaft out of the drive end frame.

11. Remove the retainer plate (20) and pull the bearings from the drive end frame.

NOTE: When tightening the outside nut on the DC output terminal, torque the nut to 30-35 ft-lbs (41-47 N·m). The lower nut should be held secure while tightening the top nut.

REASSEMBLY

NOTE: When installing the single row bearing into the drive end frame, press against the outer race only to avoid loading the bearings. Attach the bearing retainer plate (20) and press against the bearing inner race to force the assembly over the rotor shaft. To avoid pressure on the bronze ring in the rotor, support the inside of the rotor against the shaft, and place the shaft in an upright position to facilitate the assembly procedure. Press against the inner race to force the double row bearing over the shaft. When attaching the field to the diode end frame, make sure the mating surfaces are perfectly clean and tighten the mounting screw securely.

1. Reassembly in the reverse order of the "Disassembly" procedure.

2. Slid pulley onto splined end of shaft, hold pulley in a non-slip device (rubber snubbing vice) and torque to 200 ft-lbs (271 N·m) (Cat, Cummins & Series 60 Installations).

CAUTION

Do not operate the alternator unless the unit is completely assembled.

INSTALLATION (DIRECT DRIVE)

NOTE: Early production coaches equipped with the 8V-92 engine installation have the alternator geared directly into the rear flywheel housing gear case through an adapter mounting and alignment plate. The adapter is installed and aligned by dial indicator device prior to installation of the alternator.

1. Position gasket and adapter on flywheel housing.

NOTE: Gasket must have notch at inside edge of large circle for proper internal oil drainage. Coat both sides of gasket with Permalox HH195 before installation.

2. Center the adapter plate over cam gear using feeler gauge or other means. Install and tighten the four upper adapter bolts to 20 ft-lbs (27 N·m) torque. Adjust the two positioning setscrews to contact the flywheel housing.

3. Place magnetic base (for dial indicator) on the hexhead capscrew mounting cam gear to camshaft. Install dial indicator on base and set stylus to contact inside edge of adapter plate bore. Set dial indicator to zero (Figure 6).

NOTE: A tool is available which quickly mounts a dial indicator on the 53-tooth alternator drive gear for alignment of the adapter plate. This tool is available from Kent-Moore Corporation Service Tool Division or through a Detroit Diesel Allison distributor. The Kent-Moore tool number is J29893

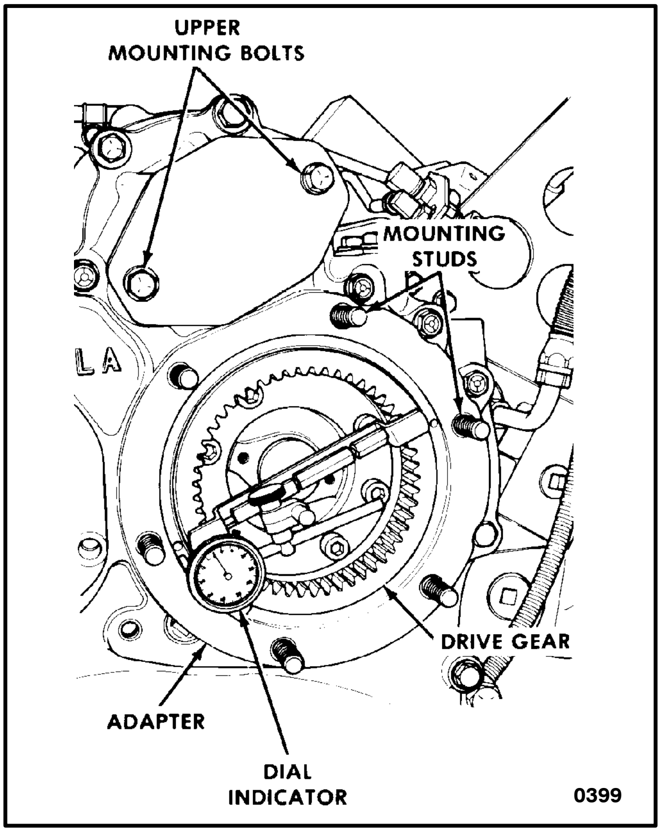


Figure 6. Generator Drive Gear Alignment

4. Place a socket wrench on the engine pulley mounting bolt. Bar the engine over. The dial indicator must rotate clockwise at least 180 degrees of one revolution. The adapter plate is centered if the dial indicator reads within ±0.002 (total indicator run-out). If satisfactory, proceed to step 6.

CAUTION

Engine must always be rotated in a clockwise direction when viewed from engine front. Rotating the engine in the wrong direction will loosen the crankshaft pulley mounting bolt. Engine damage will result when the engine is started. An assistant is necessary to bar the engine over while the dial indicator is read.

5. If runout is more than ±0.002 (total indicator run-out), loosen the four upper adapter bolts. Back off the two setscrews and readjust them until the dial indicator reads within tolerance when the engine is barred over. Repeat the procedure until the required reading is attained, or until it is determined that the adapter plate is out-of-round or otherwise defective. Replace as necessary.

6. Remove the dial indicator and magnetic base.

7. Tighten the five upper mounting hex nuts to 53-56 ft-lbs and lower hex nut to 30-35 ft-lbs (71-75 and 40-47 N·m) torque (Figure 7).

8. Reconnect all oil lines, and wiring harnesses to the alternator.

INSTALLATION (BELT DRIVEN)

1. Install alternator in the reverse order of the “Removal” procedure and torque mountings to their specification.

2. Retension belt per the “Belt Tensioning” procedure described earlier in this section.

INITIAL START-UP PROCEDURE

After installing a replacement alternator the following start-up procedure must be performed to fill circulating oil cavities and prevent an alternator over-heat condition.

1. Turn battery disconnect switch to “OFF”.

2. Disconnect and remove the field relay from rear junction box.

3. Turn all dash switches “OFF”, and place battery disconnect switch to “ON.”.

4. Turn the master switch to “ON”, and start engine.

5. Run the engine for five minutes to ensure that engine oil has circulated into the alternator.

6. Stop engine, turn master switch “OFF” and turn battery disconnect switch to “OFF”.

7. Reinstall field relay in rear junction box.

CAUTION

Operating the alternator with load and without circulating oil will cause the alternator to overheat, resulting in damage to the winding and diodes.

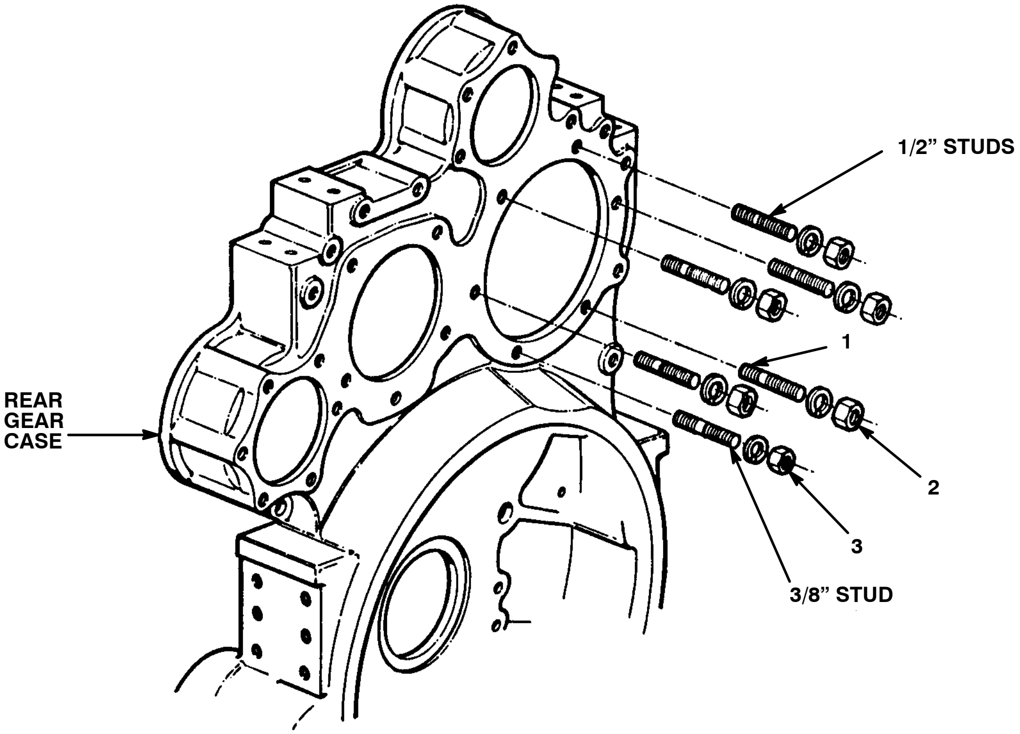


Figure 7. Alternator Mounting Torques

TORQUE SPECIFICATIONS

1. Alternator Mounting Studs-to-Rear Gear Case	20-25 ft-lbs (27-33 N·m)
2. Alternator-to-Rear Gear Case 1/2-13 UNC Hex Nuts	53-56 ft-lbs (71-75 N·m)
3. Alternator-to-Rear Gear Case 3/8-16 UNC Bottom Hex Nut	30-35 ft-lbs (35-40 N·m)
Alternator Drive Pulley Hex Nut	200 ft-lbs (271 N·m)
Alternator-to-Bottom Mounting Bracket (Cummins Installations)	70 ft-lbs (94 N·m)
Alternator-to-Top Mounting Bracket (Cummins Installations)	40 ft-lbs (54 N·m)

SPECIFICATIONS

ALTERNATOR

Manufacturer	Delco-Remy
Part Number - Gear Driven 8V-92 Installations (W/Flexible Leads)	7G-3-55
Part Number - Belt Driven Cat, Cummins & Series 60 Installations (W/Flexible Leads)	7L-3-228
Model	50 DN (Series 600)
Amperes (24 volts Minimum Recharging)	7.2-8.0
Amperes (24 volts Hot Output)	270 at 80°F (27°C) Ambient
Voltage (Maximum)	28 Volts
Drive RPM (Approximate)	3000
Ground	Negative

ALTERNATOR DRIVE BELT

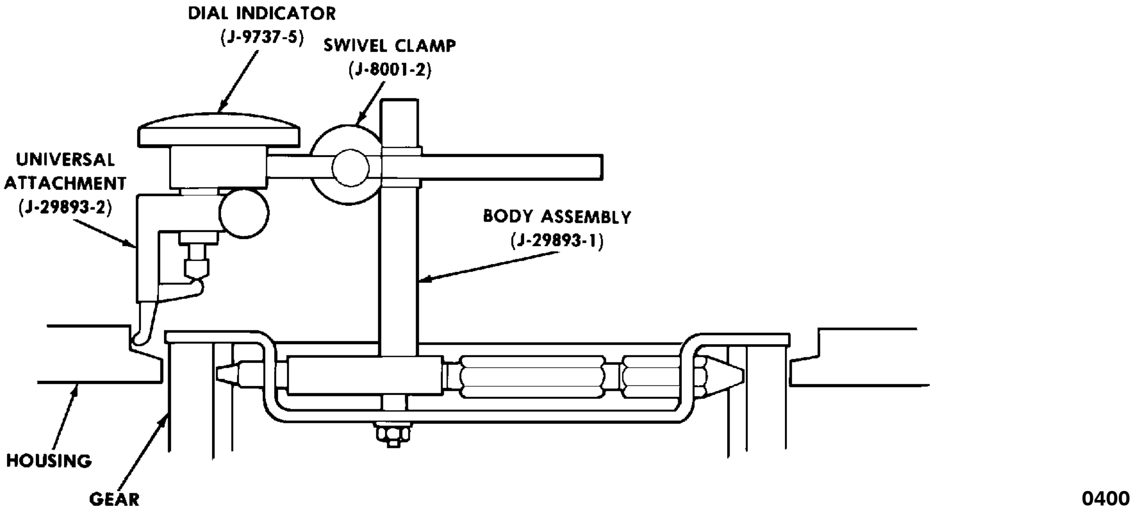
Part Number (Series 60 Installations)	8L-27-129 (12 Rib)
Part Number (Cummins Installation) (Used Prior To 47994)	8L-27-96 (10 Rib)
Part Number (Cummins Installation) (Effective With 47994)	8L-27-130 (10 Rib)
Part Number (Caterpillar Installations) (Used Prior To 48849)	8L-27-115 (8 Rib)
Part Number (Caterpillar Installations) (Effective With 48849)	8L-27-128 (8 Rib)

ALTERNATOR PULLEY (BELT DRIVEN)

Part Number (Series 60 Installations)	23512289 (12 Rib)
Part Number (Cummins Installation)	7L-3-87 (12 Rib)
Part Number (Cummins Installation)	8L-4-67 (10 Rib)
Part Number (Caterpillar Installations)	7L-3-119 (3 inch)
Part Number (Caterpillar Installations)	7L-3-229 (4 inch)

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS.



Generator Drive Gear Alignment Tool (J-29893) Installed

SECTION 7C

VOLTAGE REGULATOR

CONTENTS OF THIS SECTION

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General Description	7C-1
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Adjusting Voltage	7C-5
Specifications	7C-6

GENERAL DESCRIPTION

The voltage regulator (Figure 1) is an assembly composed principally of capacitors, resistors and transistors. These components are mounted on a printed circuit board to form a static unit containing no moving parts. Regulators of this type have terminals marked NEG, FLD and POS.

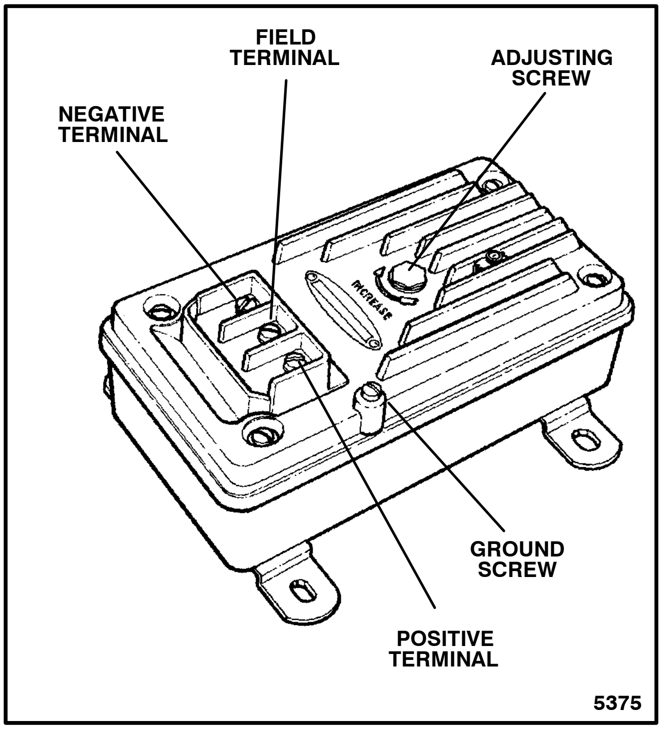

Figure 1. Voltage Regulator

The voltage regulator is mounted to the rear bulkhead, inside the rear left-hand baggage compartment. The cover contains a hole through which the regulator adjusting screw can be reached. An Allen screw plug covering the regulator adjusting screw must be removed to adjust the regulator (Figure 2).

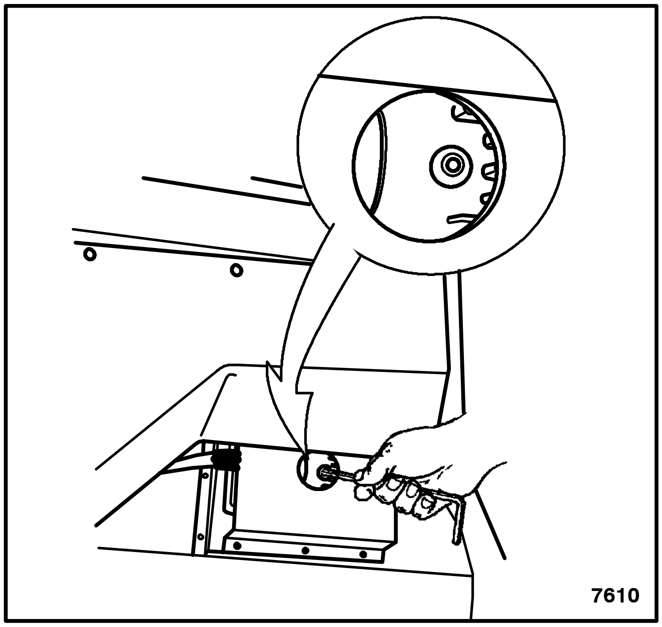

Figure 2. Regulator Adjusting Screw

The regulator limits the alternator voltage to a pre-set value by controlling the alternator field current. This is the only function the regulator performs in the charging system.

The voltage at which the alternator operates is determined by the regulator adjustment. Once adjusted, the alternator voltage remains constant, since the regulator is unaffected by length of service, changes in temperature, or changes in alternator output and speed.

A typical wiring diagram of a negative ground system is illustrated in (Figure 3). This diagram shows only the basic charging system components, and does not show other components such as control relays.

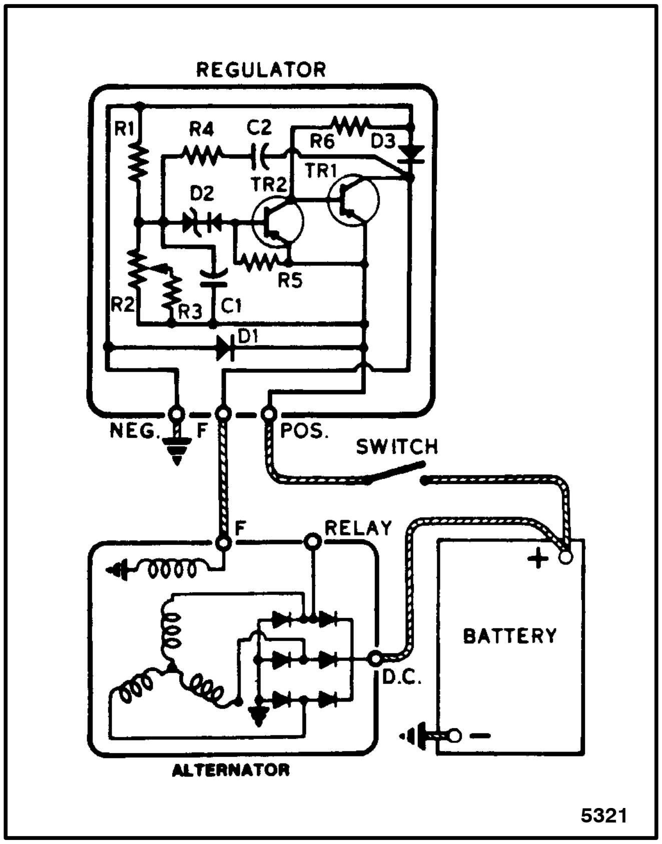

Figure 3. Charging System Diagram

MAINTENANCE

TROUBLESHOOTING

Trouble in the charging system will usually be indicated by undercharged or overcharged batteries. Either condition can result from an improper voltage regulator setting.

The ideal voltage setting is the one which will maintain the batteries in a fully charged condition with a minimum depletion of water. A record of water usage and battery specific gravity checks over a service period of reasonable length will establish the ideal voltage setting for the vehicle involved. Voltages above 27.2 ±0.3 volts can cause high battery usage and can cause the 3N-124 overvoltage protection unit to trip, preventing the alternator from charging.

TEST PROCEDURE

1. Check and set the voltage regulator to 27.2 ±0.3 volts with the coach running at fast idle and with the headlamps "ON".
2. Turn "ON" the A/C switch and slowly open the engine throttle until full throttle is reached.
3. If the voltage rises above 27.2 ±0.3 volts, reset or replace the regulator.
4. If the voltage regulator reading does not exceed 27.2 ±0.3 volts, it may be left in service.
5. Test complete.

Where maintenance-free batteries are used, the absence of gassing and the continuous appearance of the green dot in the built-in hydrometer indicates the regulator voltage setting is satisfactory.

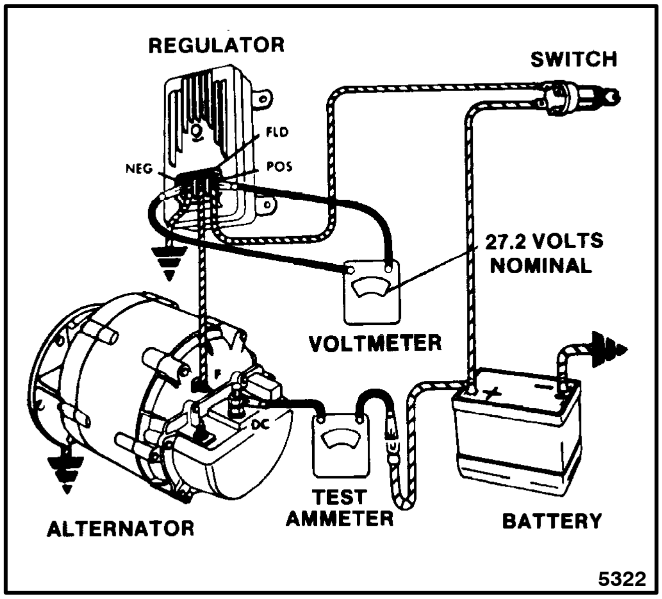

Figure 4. Voltage Regulator Check

CHECKING & SETTING PROCEDURE

To check the voltage setting, connect a voltmeter across the POS and NEG terminals on the regulator (Figure 4). Operate the engine at approximately 1,000 RPM (about 2,300 alternator RPM) with accessories turned on to obtain 20-200 amperes alternator output and note the voltage setting. The voltage should be steady and reasonably close to 27.2 ±0.3 volts. Desired variations can be obtained by turning the adjusting screw (Figure 5). This will change the voltage to meet the needs of the vehicle as dictated by operating conditions.

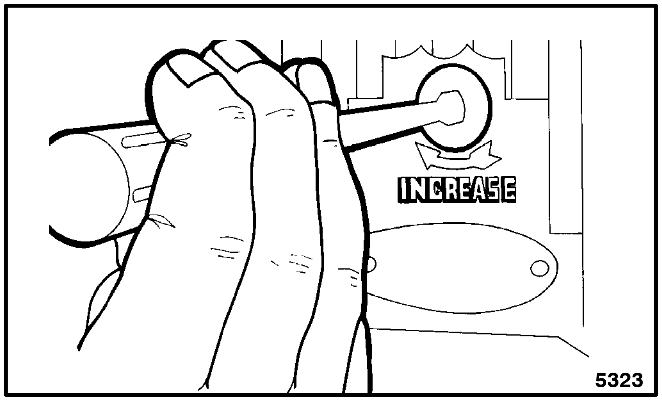

Figure 5. Adjusting Voltage Regulator

If the voltage setting is steady and reasonably close to the specified value and the battery is undercharged, raise the setting by 0.3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, the alternator should be checked as follows and as shown in (Figure 6).

1. Stop alternator, turn off all accessories and disconnect battery ground cable.

2. Disconnect all leads from the alternator and from the alternator field.

⚠ CAUTION ⚠

Do not allow leads to touch vehicle ground.

3. Connect a voltmeter and ammeter in the circuit at the DC terminal on the alternator.

4. Connect a jumper lead from the alternator DC terminal to the field terminal.

5. Connect a carbon pile load across the battery. Turn to "OFF" position.

6. Reconnect battery ground cable.

7. Turn on all vehicle accessories.

8. Operate alternator and adjust carbon pile load as required for output of 80 amps at 1,200 RPM or 225 amps at 2,500 RPM (cold).

9. Check the alternator field winding as follows:

NOTE: Turn the battery disconnect switch "OFF" and the engine run switch "OFF".

Alternators with one field terminal - Disconnect the lead from the field terminal and connect an ohmmeter from the field terminal to ground. For alternators with two field terminals, disconnect all leads from the field terminals and connect an ohmmeter across the terminals.

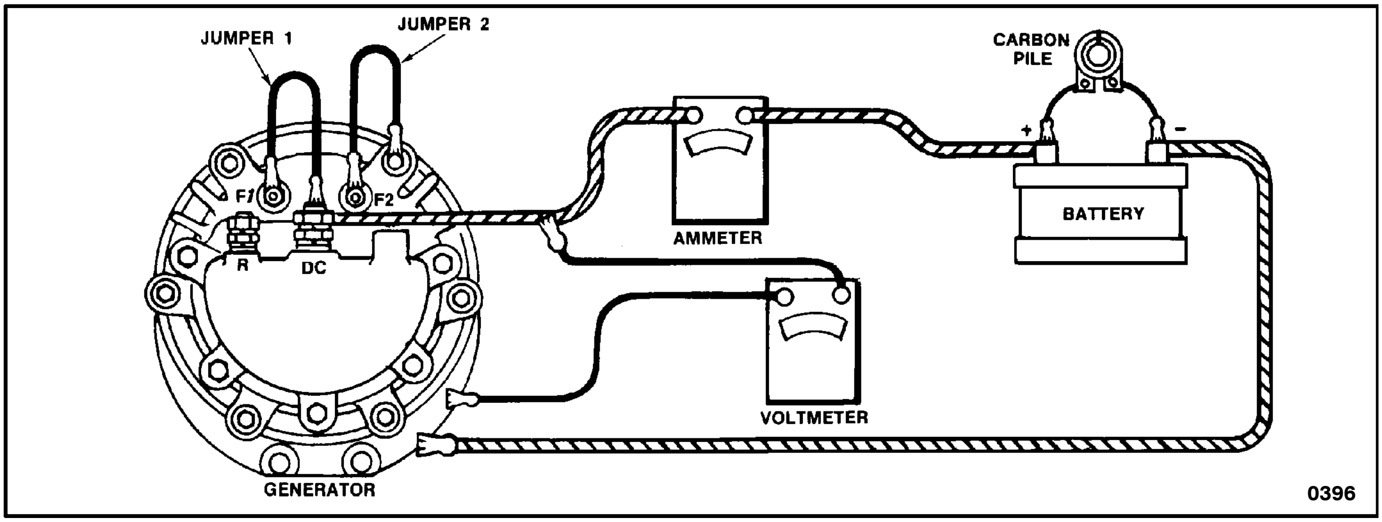

Figure 6. Alternator Output Test

A resistance reading above normal indicates an open, and a resistance reading less than normal indicates a short or ground. The normal resistance can be calculated by dividing the indicated voltage by the field current rating of 5.95 volts ±0.25 volts. The normal resistance value should be at or near midscale on the ohmmeter for accuracy.

An alternate method of checking is to connect a battery of specified voltage and an ammeter in series with the field winding and compare readings with published specifications in Delco-Remy Service Bulletin 1G-186 and 1G-188.

To check for a ground, connect the ohmmeter from either field terminal to ground. A reading equal to or less than the normal resistance value indicates a ground.

The alternator is defective if it does not produce rated output or if field windings are faulty. If the alternator provides rated output and field windings check satisfactorily, the regulator should be checked as covered under Regulator Checks.

If the voltage setting as checked above is steady and reasonably close to the specified value, lower the setting by 0.3 volt and check for an improved battery condition over a minimum service period of 48 hours. If the voltage cannot be adjusted to the desired value, proceed as follows: where the alternator field is grounded internally in the alternator as in (Figure 3), a shorted or grounded field or a defective regulator can cause an overcharged battery. The field winding can be checked as above. If the field winding is found not to be defective, the alternator is not defective, and the regulator should be checked as covered in “Testing” procedure.

INTERNAL COMPONENT TESTS

Separate the cover from the base, and then remove the panel assembly from the cover (Figure 1). Carefully note the location of all washers and lockwashers.

Before making electrical checks, visually inspect the components and make sure all soldered connections are secure. Various electrical checks with an ohmmeter can be made to determine which components are defective.

The component parts are identified in (Figure 7) and are keyed to Figure 3. Resistor R9 may not be used on 24-volt systems.

The ohmmeter must be accurate, and should be a scale type meter with a 1½ or 3-volt cell. Most digital ohmmeters cannot be used to check semiconductors; however, some digital ohmmeters are specially designed to test semiconductors and can be used to test components in the regulator. Consult the ohmmeter manufacturer concerning the meter capabilities.

It is important that all of the following checks be made. If a defective part is found, replace it before proceeding with the remaining checks. Be sure to make all the checks as more than one component may be defective.

A defective part may be replaced by removing the attaching screws and unsoldering the connections.

CAUTION

When resoldering, limit solder time to a minimum as excessive heat may damage the printed circuit and component parts.

However, firmly soldered connections are essential for satisfactory operation. A resin core 63% tin, 37% lead solder with 360°F melting point is recommended along with a soldering iron rated at 50 watts or less. Use extreme care to avoid overheating.

Before checking the circuit board, remove transistor TR1, which must be checked separately. Connect the ohmmeter as shown in Figure 8 and then reverse the ohmmeter leads to obtain two readings on the same component. Use the middle scale on scale-type meters; the 300 ohm value should be within, or nearly within, the middle third of the scale. For the following checks refer to (Figure 8).

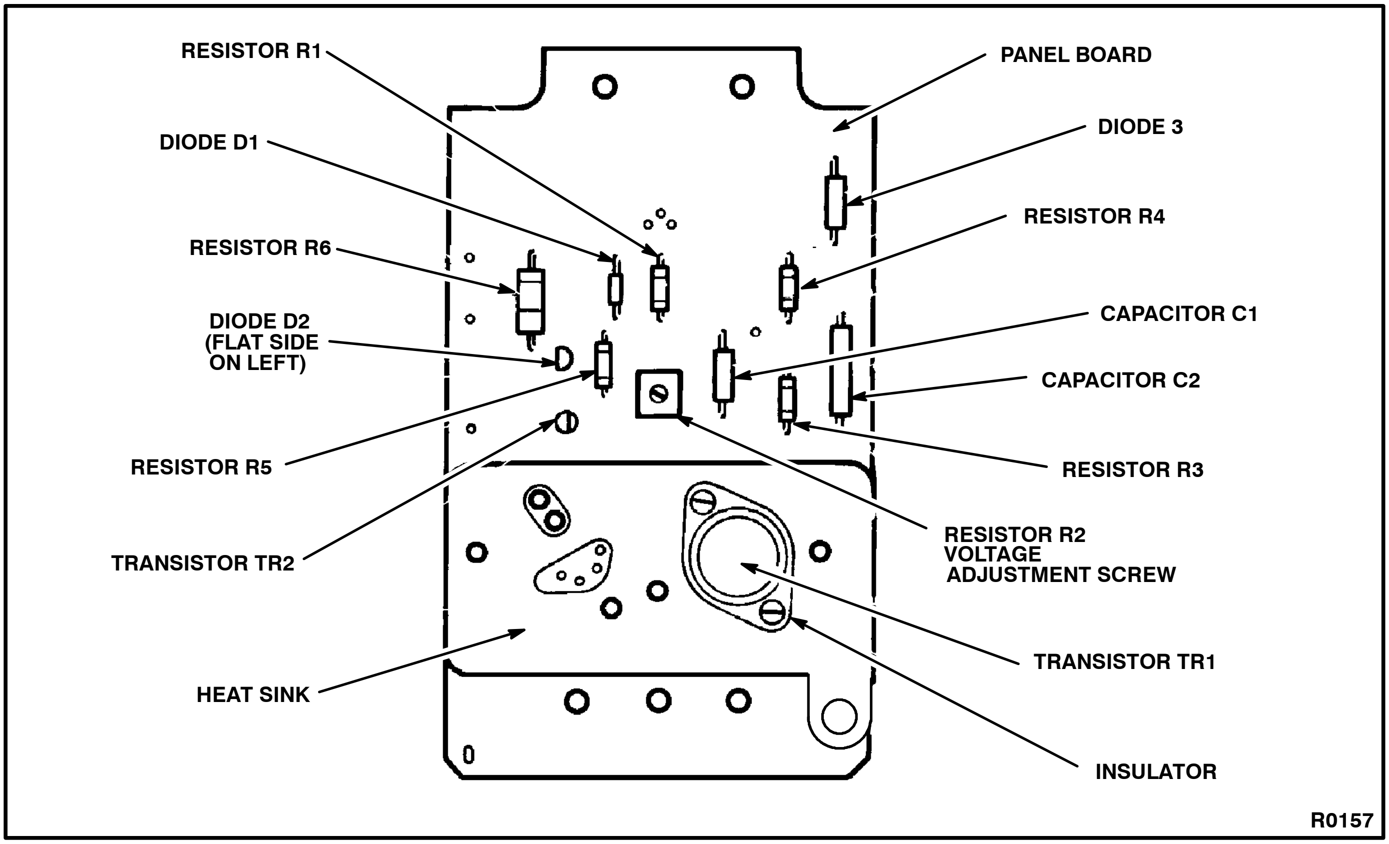

Figure 7. Regulator Components

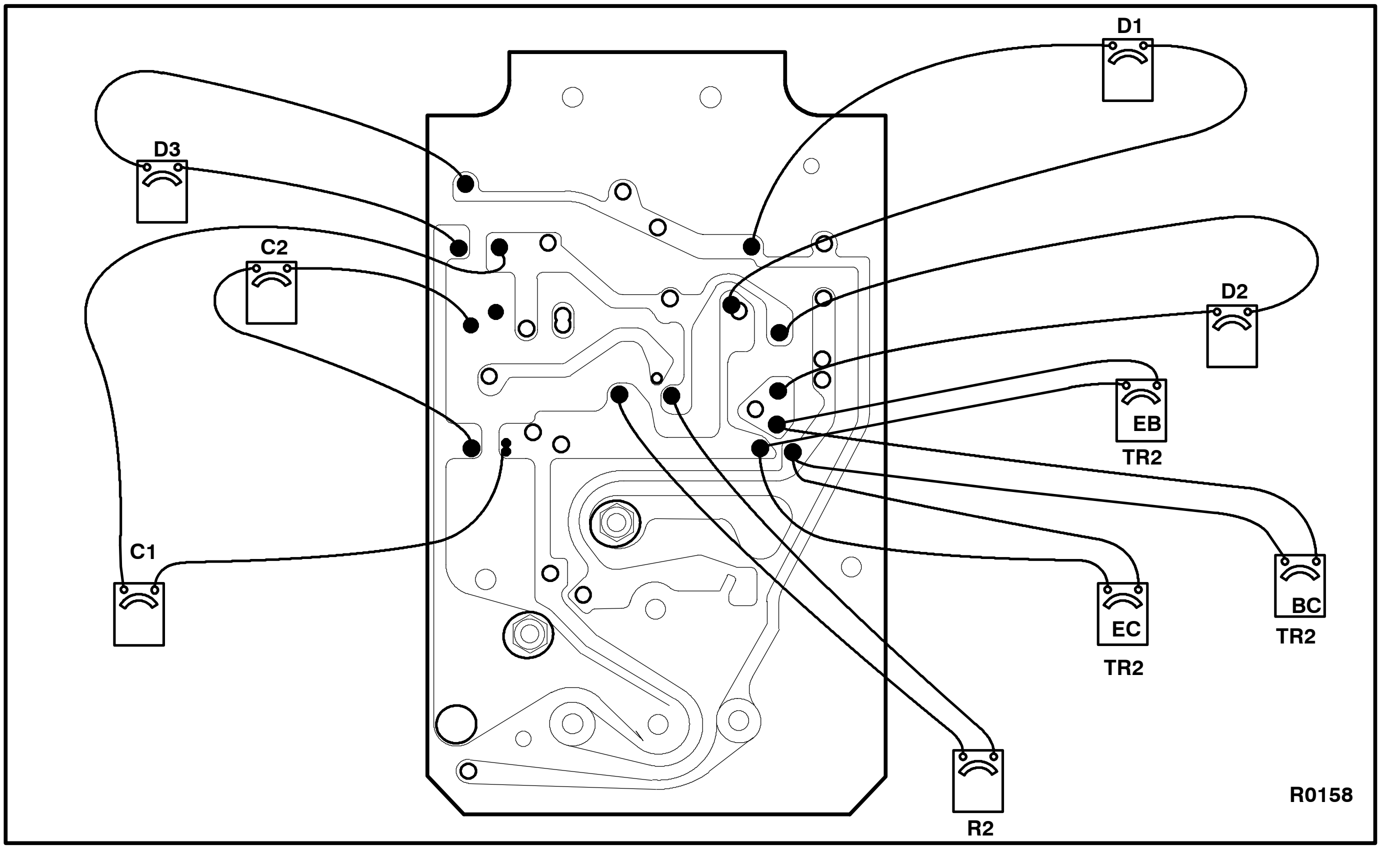

Figure 8. Testing Internal Components

Capacitors C1 and C2 - The ohmmeter should read high and low on each capacitor. If not, replace capacitor.

Diodes D1, D2 and D3 - Each diode should give one high and one low reading. If not, replace diode.

Resistor R2 - Turn voltage adjustment screw with ohmmeter connected each way. Reading should change as slotted screw is turned. If not, replace R2.

Transistor TR2 - Change the ohmmeter to use the low scale. Check EB; should read low and high. Check BC; should read low and high. Check EC; both should read high. If not, replace TR2.

Transistor TR1 - Use the low scale. Each of the three checks should read low and high. If not, replace TR1 (Figure 9).

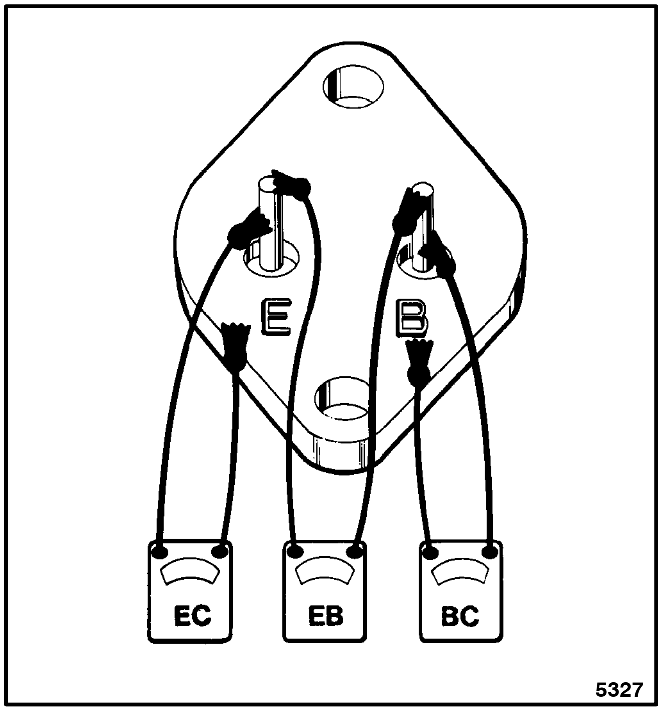

Figure 9. Ohmmeter Check of TR1

ADJUSTING VOLTAGE

After repair, the regulator must be adjusted to the desired voltage setting. Following the “Checking & Setting” procedures, Turn the adjusting screw full range and observe the voltmeter to ensure that the voltage is being controlled, then adjust to the setting desired or the setting listed in Delco Remy Service Test Specifications 1R-188.

SPECIFICATIONS

REGULATOR (24-VOLT)

Manufacturer	Delco-Remy
Part No.	7G-4-1
Model Number	1118447
Type	Transistor
Voltage Adjustment	External Screw

SECTION 7D

42MT STARTER (ELECTRIC)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	7D-1
Operation	7D-1
Maintenance	7D-2
Specifications	7D-10

GENERAL DESCRIPTION

The starter is a heavy duty solenoid operated, D.C. cranking motor. The unit has a shift lever and solenoid plunger that are totally enclosed to protect it from exposure to dirt, icing conditions and splash. The commutator end cap can be removed to inspect the brushes (Figures 1 & 2).

OPERATION

NOTE: The 12V disconnect switch must be “On” on coaches with 12V exterior lighting. In addition, the engine run switch in the engine compartment and the master control switch on the instrument panel must be “ON” before the engine will start.

When engaged the pinion is moved into mesh with the ring gear by the action of the solenoid. The pinion remains engaged until the solenoid circuit is interrupted. In case of a butt engagement, the motor will not be energized to prevent damage to the pinion and gear teeth.

A basic circuit is shown in (Figure 3). When the start switch is closed, the magnetic switch contacts close, and the solenoid windings are connected to the battery. The resulting plunger and shift lever movement cause the pinion to engage the engine flywheel ring gear and the solenoid main contacts to close, and cranking takes place.

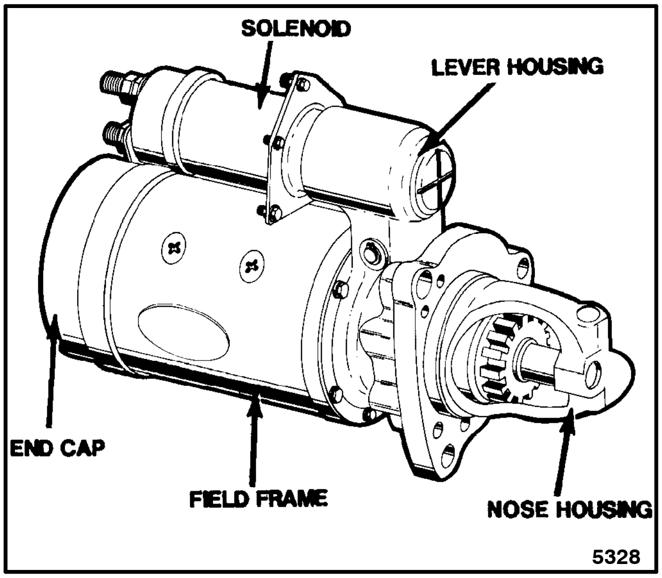

Figure 1. 42MT Starter Motor

To prevent excessive overrun and damage to the drive and armature windings, the switch must be opened immediately after the engine starts. Pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. A cranking period should never exceed 30 seconds without stopping to allow the motor to cool.

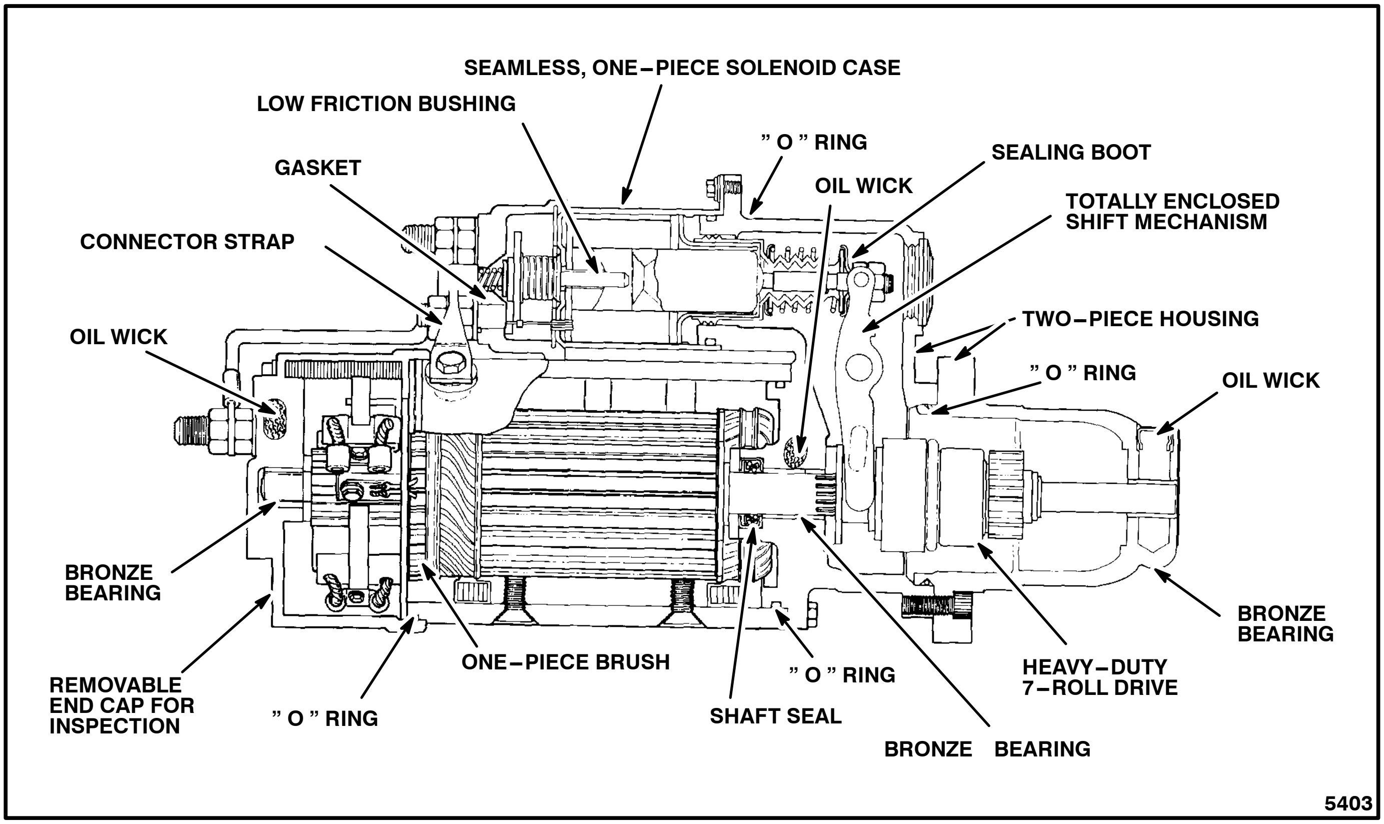
SEAMLESS, ONE–PIECE SOLENOID CASE
LOW FRICTION BUSHING
" O " RING
SEALING BOOT
GASKET
OIL WICK
TOTALLY ENCLOSED SHIFT MECHANISM
CONNECTOR STRAP
TWO–PIECE HOUSING
OIL WICK
" O " RING
OIL WICK
BRONZE BEARING
BRONZE BEARING
REMOVABLE END CAP FOR INSPECTION
ONE–PIECE BRUSH
" O " RING
" O " RING
HEAVY–DUTY 7–ROLL DRIVE
SHAFT SEAL
BRONZE BEARING
5403

Figure 2. 42MT Starter Motor (Cross Sectional)

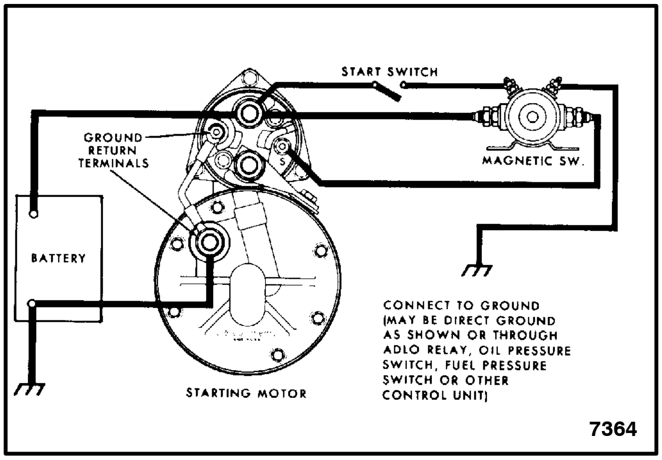
START SWITCH
GROUND RETURN TERMINALS
MAGNETIC SW.
S
BATTERY
STARTING MOTOR
CONNECT TO GROUND (MAY BE DIRECT GROUND AS SHOWN OR THROUGH ADLO RELAY, OIL PRESSURE SWITCH, FUEL PRESSURE SWITCH OR OTHER CONTROL UNIT)
7364

Figure 3. Starting Circuit

NOTE: See "Wiring Schematics" sub-section 7J for the complete starting circuit schematic.

STARTER PROTECTION

Two types of starter protection are available on the 102D Series coaches. Those with DDEC feature the 3N124 Triple Protection Device, and those with 8V-92 MUI engines use the optional Thermal Time Delay.

One of the functions of the Triple Function Protective Device is to prevent starter re-engagement after the engine is running. Further information on this device can be found under "Alarms and Signals".

The Thermal Time Delay's relay is installed in the rear J-box located in the engine compartment. This system differs from the basic protection system in that it does not, sense over-voltage to protect electrical components, or prevent the starter from re-engaging when the engine has started.

The Thermal Time Delay system provides a 20 second override of the oil pressure switch. This time period is triggered by the activation of the start switch. This is followed by a 20-30 second reset time during which the oil pressure switch functions normally. This cycle is requested as long as the start switch is activated. A 6 psi fuel pressure switch is also used to disengage the starter when a pressure of 6 psi is sensed in the fuel system (when the engine starts). Refer to the Thermal Time Delay wiring diagram in the "Wiring Schematics".

MAINTENANCE

Under normal operating conditions, no maintenance will be required between engine overhaul periods. At time of engine overhaul, starter motors should be disassembled, inspected, cleaned and tested as described in succeeding paragraphs.

LUBRICATION

Lubrication is provided in the sintered bronze bushings by an oil saturated wick. Oil can be added to each wick by removing an oil reservoir cup which is accessible on the outside of the motor.

All wicks and oil reservoirs should be saturated with an SAE 20 oil and a light coating of 10 SAE oil underneath the splines of the clutch. Other than periodic lubrication and keeping cable connections clean and tight, the starter requires no periodic maintenance. The brushes can be inspected by removing the commutator end cap. However, the starter must be removed and partially disassembled to replace the brushes.

TROUBLESHOOTING - (START CIRCUIT)

If the starter is not performing properly, make the following checks to determine which part of the circuit is at fault. Ensure that the battery is fully charged. The wiring, switches and starting motor cannot be checked if the battery is defective or discharged.

1. Inspect the wiring for damage. Inspect all connections to the starting motor, solenoid, magnetic switch, ignition switch or any other control switch, and battery, including all ground connections.

2. Clean and tighten all connections as required.

3. Inspect all switches to determine their condition. From the coach wiring diagram, determine which circuits should be energized with the starting switches closed. Use a voltmeter to detect any open circuits.

4. If the battery, wiring and switches are in satisfactory condition, and the engine is known to be functioning properly, remove the motor and follow the test procedures outlined below.

5. With the starter removed from the engine, the armature should be checked for freedom of rotation by prying the pinion with a screwdriver. Tight bearings, a bent armature shaft, or a loose pole shoe screw will cause the armature to not turn freely.

6. If the armature does not turn freely, the motor should be disassembled immediately. However, if the armature does rotate freely, the motor should be given a no-load test before disassembly.

No-Load Test

The no-load test can be used to indicate normal operation on a motor before installation or to identify specific defects. These defects can be verified with tests after the motor is disassembled. Also, the no-load test can identify open or shorted fields, which are difficult to check when disassembled. The no-load test may be used to indicate normal operation on a repaired motor before installation.

1. Connect a voltmeter from the motor terminal to the ground return terminal, and use an RPM indicator to measure armature speed (Figure 4).

2. Connect the motor and an ammeter in series with a fully charged battery of the specified voltage, and a switch in the "open" position from the solenoid battery terminal to the solenoid switch terminal.

3. Close the switch and compare the RPM, current, and voltage reading with the specifications in the following table.

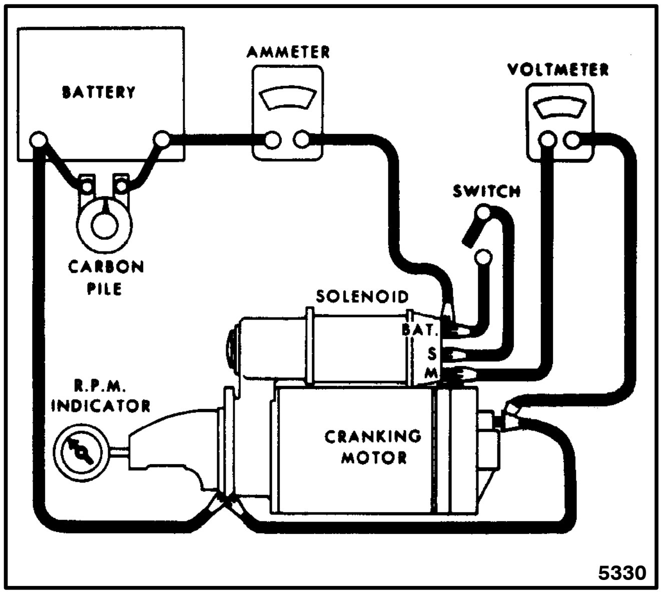

Figure 4. No-Load Test

NO-LOAD STARTER TEST SPECIFICATIONS

Starter	Test Voltage	Min. Current Draw (Amps)	Max. Current Draw (Amps)	Min. RPM	Max. RPM
42MT (7G-1-39)	20	60	90	6300	8400

NOTE: Rated current draw and no-load speed indicate normal condition of the starting motor.

It is not necessary to obtain the exact voltage specified in the chart, as an accurate interpretation can be made by recognizing that if the voltage is slightly higher, the RPM will be proportionately higher with the current remaining essentially unchanged. However, if the exact voltage is desired, a carbon pile connected across the battery can be used to reduce the voltage to the specified value.

If more than one 12V battery is used, connect the carbon pile to only one of the 12V batteries. Make disconnections only with the switch open.

Interpretation of Test Results

1. **Low free speed and high current draw indicates:**

a. Too much friction - tight, dirty, worn bearings, bent armature shaft or loose pole shoes allowing armature to drag.

b. Shorted armature - This can be further checked on a growler after disassembly.

c. Grounded armature or fields - Check further after disassembly.

2. **Failure to operate with high current draw indicates:**

a. A direct ground in the terminal or fields.

b. “Frozen” bearings (this should have been determined by turning the armature by hand).

3. **Failure to operate with no current draw indicates:**

a. Open field circuit - This can be checked after disassembly by inspecting terminal connections and tracing circuit with a test lamp.

b. Open armature coils - Inspect the commutator for badly burned bars after disassembly.

c. Broken brush springs, worn brushes, high insulation between the commutator bars or other causes which would prevent good contact between the brushes and commutator.

4. **Low no-load speed and low current draw indicates:** A high internal resistance due to poor connections, defective leads, dirty commutator and causes listed in Number 6.

5. **High free speed and high current draw indicates:** A shorted field. If shorted fields are suspected, replace the field coil assembly and check for improved performance.

STARTER REMOVAL

1. Place the battery disconnect switches in the battery compartment in the “OFF” position.

2. Apply the parking brake and ensure the engine run switch and rear start switch are in the “OFF” position.

3. Disconnect and label the electrical wires to the starter.

4. Remove the mounting nuts. Ensure that the starter is properly supported.

5. Pull the starter off the mounting studs and carefully remove it from the engine compartment.

STARTER DISASSEMBLY

The starter should be disassembled only to repair or replace defective parts.

1. Match-mark the solenoid, lever housing, and nose housing so the starter motor can be reassembled in the same positions.

2. Disconnect the field coil from the solenoid motor terminal and the ground return lead from the solenoid.

3. Remove the attaching bolts and separate the commutator end frame from the field frame.

4. Remove attaching screws to separate brush inspection plate assembly from field frame.

5. Separate the nose housing and field frame from lever housing by removing attaching bolts.

6. Remove pinion stop.

7. Remove armature and clutch assembly from lever housing.

8. Separate solenoid from lever housing by pulling apart.

The drive, armature and fields should not be cleaned in any degreasing tank, or with grease-dissolving solvents, since these would dissolve the lubricants in the drive and damage the insulation in the armature and field coils. All parts except the drive should be cleaned with mineral spirits and a brush. The drive can be wiped with a clean cloth.

⚠ CAUTION ⚠

Never use emery cloth to clean the commutator.

BRUSHES

Inspect the brushes for wear. If they are worn excessively when compared with a new brush, they should be replaced. Make sure the brush holders are clean and the brushes are not binding in the holders. The full brush surface should ride on the commutator to give proper performance. Check by hand to ensure that the brush springs are giving firm contact between the brushes and the commutator. If the springs are distorted or discolored, they should be replaced.

ARMATURE - (TESTING)

The armature should be checked for opens, short circuits and grounds as follows:

Opens

Inspect the points where the conductors are joined to the commutator bars for loose connections. Poor connections cause arcing and burning of the commutator bars as the cranking motor is used. If the bars are not too badly burned, repair can often be effected by resoldering the leads in the riser bars (using rosin flux), and turning the commutator in a lathe to remove the burned material.

Shorts

Short circuits in the armature are located by use of a growler. When the armature is revolved in the growler with a steel strip such as a hacksaw blade held above it, the blade will vibrate above the area of the armature core in which the short circuit is located. Shorts between bars are sometimes produced by brush dust or copper between the bars. These shorts can be eliminated by cleaning out the slots (Figure 5).

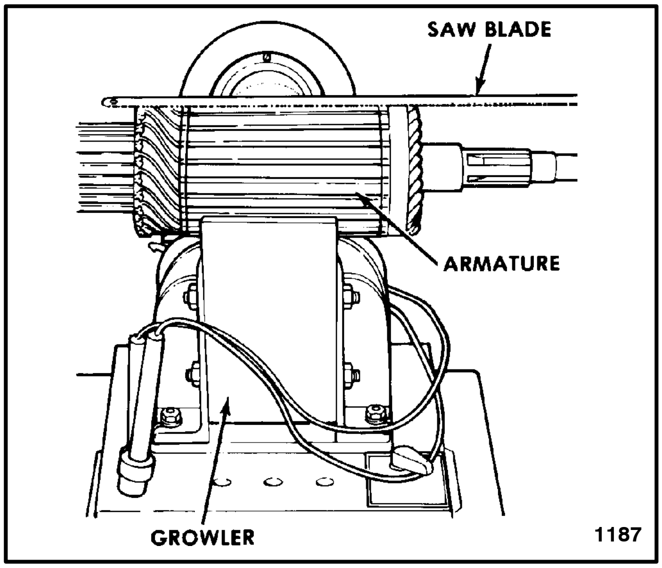

Figure 5. Checking Armature (Short)

Grounds

Grounds in the armature can be detected by the use of a 110VAC test lamp and test points. If the lamp lights when one test point is placed on the commutator with the other point on the core or shaft, the armature is grounded. Grounds occur as a result of insulation failure which is often brought about by overheating of the starting motor produced by excessively long cranking periods or by accumulation of brush dust between the commutator bars and the steel commutator ring.

FIELD COIL - (TESTING)

A typical circuit is shown in the wiring diagram of (Figure 6). The field coils can be checked for grounds and opens by using a test lamp:

Grounds

If the motor has one or more coils normally connected to ground, disconnect the ground connections during this check.

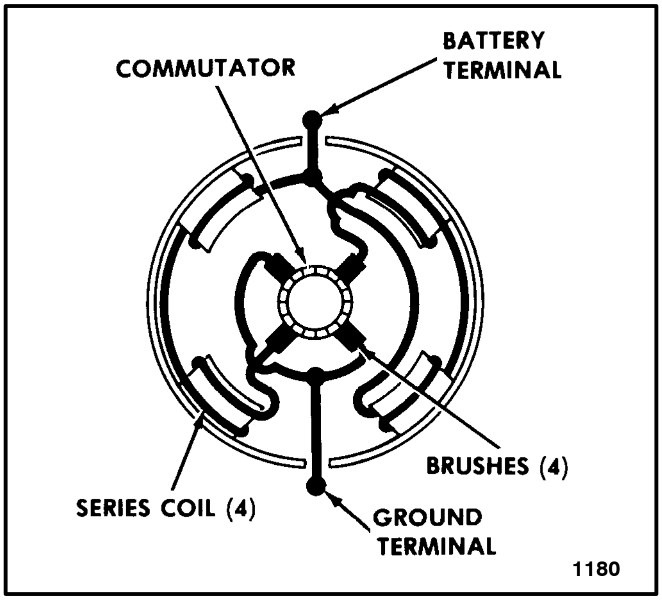
BATTERY TERMINAL
COMMUTATOR
BRUSHES (4)
SERIES COIL (4)
GROUND TERMINAL
1180

Figure 6. Starter Internal Wiring

Connect one lead of the 110VAC test lamp to the field frame and the other lead to the field connector. If the lamp lights, at least one field coil is grounded which must be repaired or replaced. This check cannot be made if the ground connection cannot be disconnected.

Opens

Connect test lamp leads to ends of field coils. If lamp does not light, the field coils are open.

Field coils can be removed from the field frame assembly by using a pole shoe screwdriver. A pole shoe spreader may also be used to prevent distortion of the field frame. Careful installation of the field coils is necessary to prevent shorting or grounding of the field coils as the pole shoes are tightened into place.

Where the pole shoe has a long lip on one side and a short lip on the other, the long lip should be assembled in the direction of armature rotation so it becomes the trailing (not leading) edge of the pole shoe.

SOLENOID - (TESTING)

With all other leads disconnected, the solenoid windings can be checked by making test connections as shown in (Figure 7).

Hold-In Winding

Make connections to the “S” and ground return terminals (Figure 8) needed, use the carbon pile to decrease the battery voltage to the value specified and compare the ammeter reading with the hold-in winding specifications. A high reading indicates a shorted winding, and a low reading indicates excessive resistance.

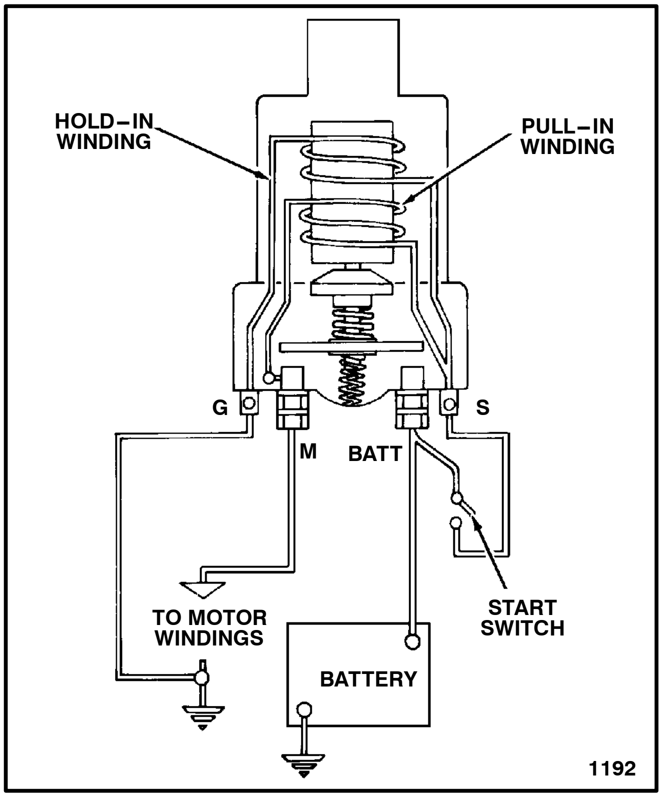
HOLD-IN WINDING
PULL-IN WINDING
G
S
M
BATT
TO MOTOR WINDINGS
START SWITCH
BATTERY
1192

Figure 7. Internal Solenoid Circuit

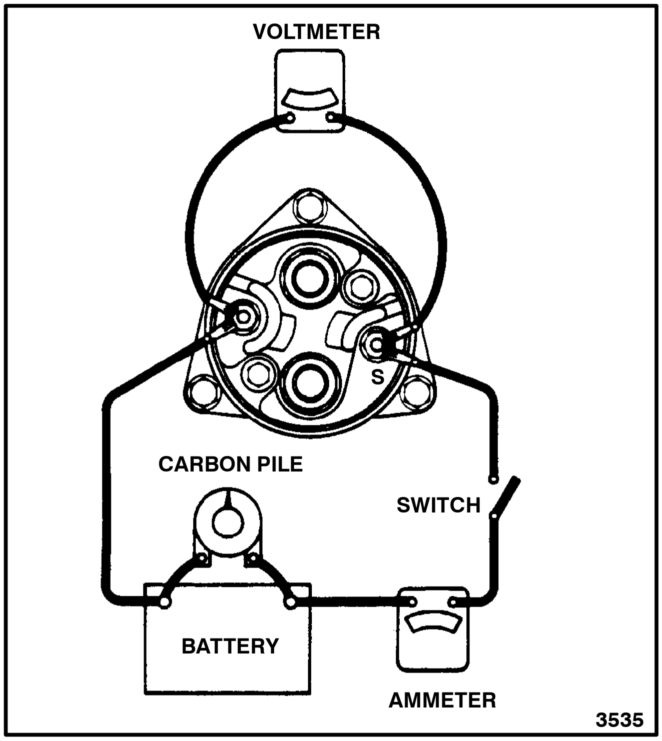
VOLTMETER
S
CARBON PILE
SWITCH
BATTERY
AMMETER
3535

Figure 8. Testing Hold-In Winding

Pull-In Winding

To check the pull-in winding, connect from the solenoid switch terminal to the solenoid motor terminal

(Figure 9). Compare with the pull-in winding specification. A high reading indicates a shorted pull-in winding, and a low reading indicates excessive resistance.

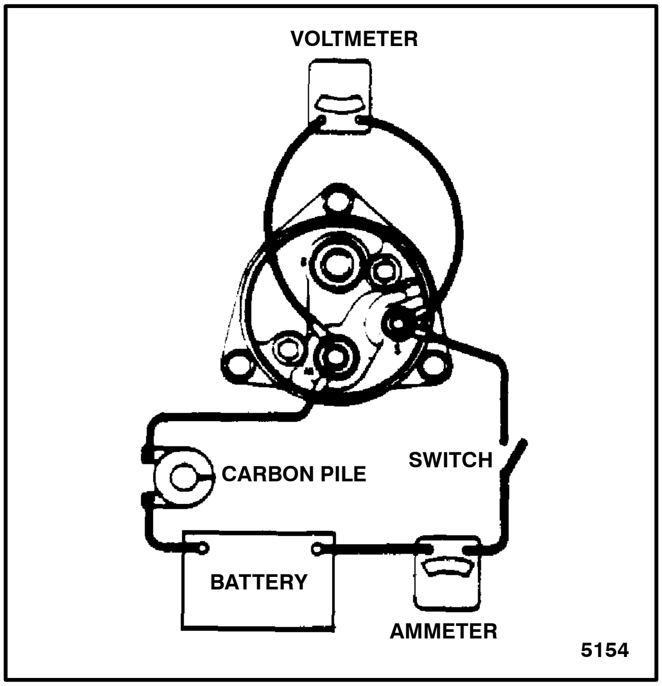

Figure 9. Testing Pull-in Winding

SOLENOID TEST SPECIFICATIONS

	Pull-In Winding		Hold-In Winding	
Solenoid	Test Voltage	Current Draw	Test Voltage	Current Draw
7G-1-84	5	8.5-10.0	20	11.0-15.0

NOTE: To avoid excessive heating, leave the pull-in winding connected no more than 10 seconds at a time. The current will decrease as the heating increases.

Grounds

To check for grounds, move battery lead from “M” terminal to a clean metal ground on the solenoid case. Ammeter should read zero. If not, hold-in or pull-in winding is grounded.

NOTE: To reduce the voltage to the specified value, connect the carbon pile between the battery and the ‘M” terminal as shown.

The magnetic switch can be checked in the same manner by connecting across its winding.

BUSHING REPLACEMENT

1. Remove the expansion plug from the armature shaft bore.

2. Remove the expansion plug from the oil reservoir and remove the pipe plug from the oil wick passage. Remove the packing land oil wick from the reservoir.

3. Press the old bushing from the end frame.

4. Dip the new bushing in an SAE 20 oil. Also, soak the wick with SAE 20 oil and insert the wick into place before pressing the bushing into the housing.

5. Press the bushing into place. DO NOT DRILL, REAM, OR MACHINE the sintered bearings in any way. These bearings are supplied to size. If drilled or reamed, the inside diameter will be too large, and the bearing pores will be sealed over.

It is not necessary to cross drill sintered bearings when used with a tangent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

The middle bearings are support bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between middle bearing and shaft is large and the clearance provides a loose fit when assembled.

6. Install a new expansion plug with gasket in the armature bore in the end frame.

CLUTCH DRIVE REPAIR

The drive pinion must rotate freely in the overrunning direction and must not slip in the cranking direction. The overrunning clutch drive can be serviced as follows. Refer to Figure 10.

Disassembly

1. Using suitable tools, remove the pinion stop cup and split washers from the sleeve. In removing the pinion stop cup, the cup will be damaged. Install a new cup at time of assembly.

2. Remove the pinion, spring retainer outer cup, spring, and spring retainer inner cup.

Inspection and Repair

1. Inspect the spring and spring retainer cups. If not in good usable condition, replace with new parts.

2. Inspect the pinion. If the teeth are chipped or cracked, replace the pinion.

3. Inspect the sleeve bushings for wear or damage. If the bushings are worn, press the old bushings out of the sleeve and press in new bushings.

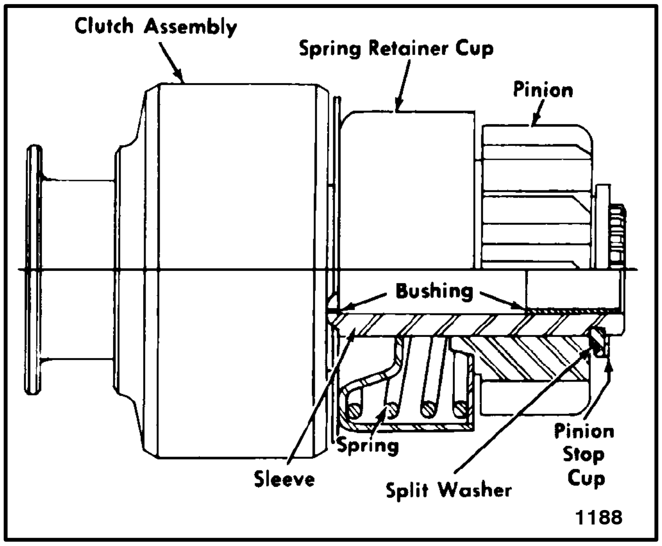

Figure 10. Checking Pinion Clearance

Assembly

1. Install the spring retainer inner cup, spring, and spring retainer outer cup on the sleeve.
2. Install the pinion and pinion stop cup on the clutch sleeve.
3. Install the split-type washers in the groove at the end of the clutch sleeve.
4. Position the clutch sleeve assembly in a vise, then with the pinion seated firmly against the pinion stop cup, and using suitable tools, bend the pinion stop cup lip over the split washers, locking the pinion stop and split washers together.

STARTER REASSEMBLY

1. To reassemble the brush plate assembly with brushes on the field frame with armature in place, lift the brushes up so the spring contacts the **side** of the brush.
2. Assemble to the field frame with the attaching screws.
3. Lift up springs and position brushes onto commutator.
4. All bearings, wicks and oil reservoirs should be saturated with SAE No. 20 oil.
5. Place a light coat of lubricant Delco Remy No. 1960954 on the washer located on the shaft between the armature and shift lever housing.

NOTE: The sintered bronze bearings have a dull finish.

6. Soak the tangent wick with SAE No. 20 oil and insert it into place. Dip the bearing in SAE No. 20 oil and press into place.

CAUTION

Do not drill, ream or machine sintered bearings in any way! These bearings are supplied to size.

It is not necessary to cross-drill a sintered bearing when used with a tangent wick. Because the bearing is so highly porous, oil from the wick touching the outside bearing surface will bleed through and lubricate the shaft.

Middle bearings are support bearings and prevent armature deflection during cranking. As compared to end frame bearings, the clearance between the middle bearing and shaft is large and provides a loose fit when assembled.

PINION CLEARANCE

To check pinion or drive clearance follow the steps listed below.

1. Make connections as shown (Figure 11).

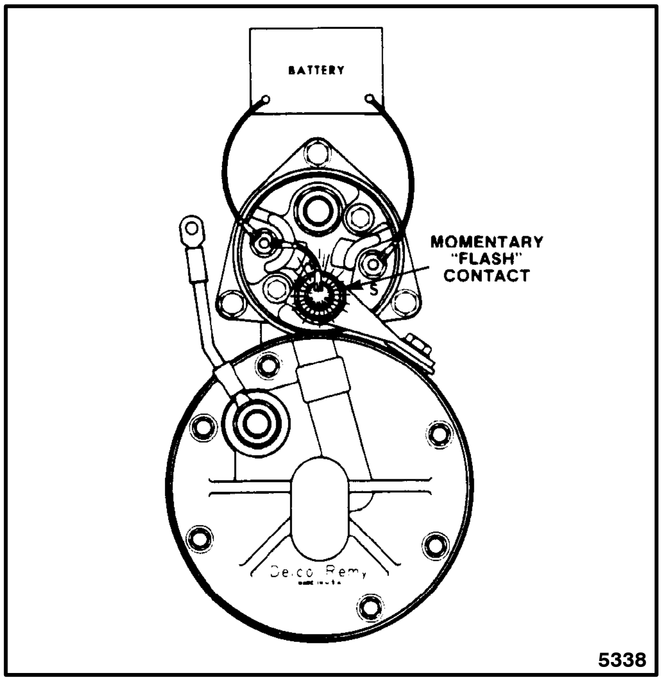

Figure 11. Checking Pinion Clearance

2. **Momentarily** flash a jumper lead from ground return terminal to terminal MTR. The drive will now shift into cranking position and remain so until the battery is disconnected.
3. Push the pinion or drive back toward the commutator end to eliminate slack movement.
4. Measure the distance between drive and housing (Figure 12).

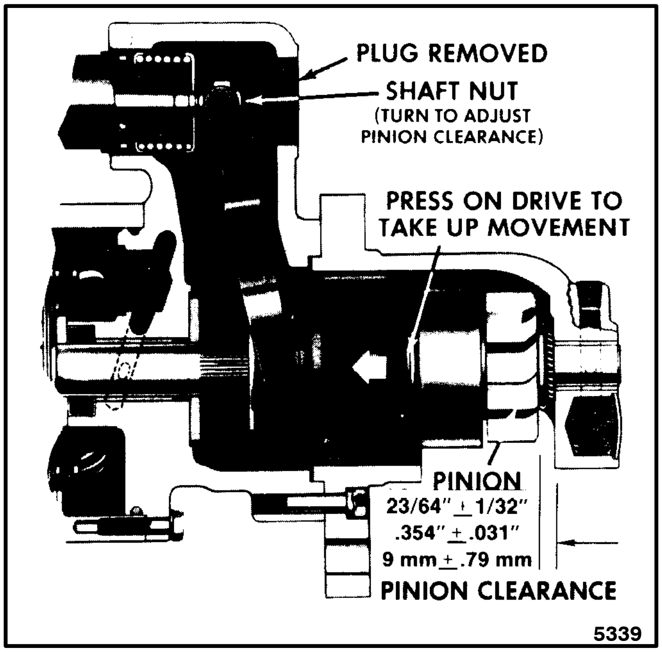
PLUG REMOVED
SHAFT NUT
(TURN TO ADJUST PINION CLEARANCE)
PRESS ON DRIVE TO TAKE UP MOVEMENT
PINION
23/64" ± 1/32"
.354" ± .031"
9 mm ± .79 mm
PINION CLEARANCE
5339

Figure 12. Checking Pinion Clearance

5. Adjust clearance by removing plug and turning shaft nut (Figure 12). Although typical specifications are shown, always refer to Delco Remy bulletin 1M-188 for specifications applying to specific models.

STARTER INSTALLATION

1. Properly supporting the starter, raise it into position on the studs that fasten it to the engine.
2. Secure the starter with the mounting fasteners and tighten to 140 ft.lbs. (190 N·m) torques for all engine installations with aluminum housings.
3. Connect the electrical wires as previously labeled.
4. Turn "ON" the battery disconnect switch.
5. Start the engine to test operation. (Figure 13).

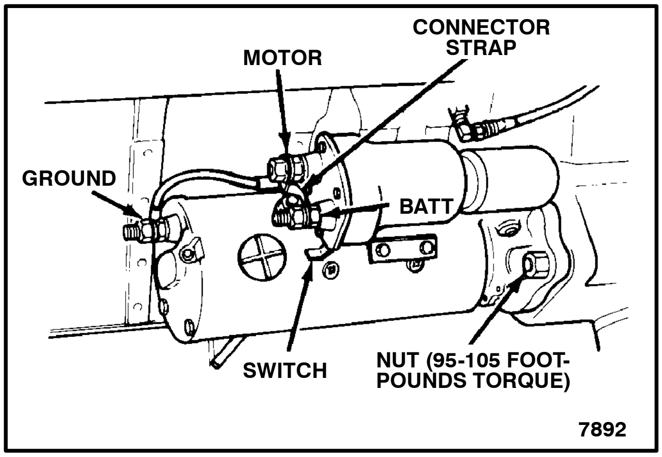
CONNECTOR STRAP
MOTOR
GROUND
BATT
SWITCH
NUT (95-105 FOOT-POUNDS TORQUE)
7892

Figure 13. Starter Installed

STARTER LOCKOUT

The starter has a starter lockout relay requiring a 12V disconnect switch in the battery compartment to be "ON" before the engine will start. This ensures that the 12V switch will not be inadvertent left "OFF" on coaches with 12V exterior lighting and running lights. In addition, the engine run switch in the engine compartment and the master control switch on the instrument panel must be "ON" before the engine will start.

SPECIFICATIONS

STARTER MOTOR

Manufacturer	Delco-Remy
Part Number (Series 60 & Cummins Installations)	7G-1-39
Part Number (Cat Installations)	7L-1-54
Rotation (Viewing Drive End)	CW
Pinion Clearance	.354”+.031” (9 mm + .79 mm)
No-Load Test	
Volts	20
Current Draw (Amps)	60 Min., 75 Max.
RPM	6500 Min., 7700 Max.

STARTER SOLENOID

Manufacturer	Delco-Remy
Part Number	7G-1-84
Test Specifications	
Pull-In-Winding	8.5-10.0 Amps at 5 VDC
Hold-In Winding	11.0-15.0 Amps at 20 VDC

SECTION 7E

SPEEDOMETER

CONTENTS OF THIS SECTION

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Alternate Electronic Speedometer 7E-2
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ELECTRONIC SPEEDOMETER WITH MAGNETIC SENSOR

An electronic speedometer is installed as standard equipment in the driver's instrument panel. The speedometer head is installed on the left side of the instrument panel. It is identified by model, 24-volt - 480 revs/mile - 4 bolts. A sensor is mounted on a plate at the back of the left front wheel drum. Also, four bolts are mounted 90 degrees apart on the brake drum which serve as a signal source.

The speedometer converts frequencies from the signal source to voltage inside the instrument (Figure 1). As vehicle speed increases or decreases, the varying voltage moves the pointer across the face of the speedometer to the proper indication (MPH/KPH).

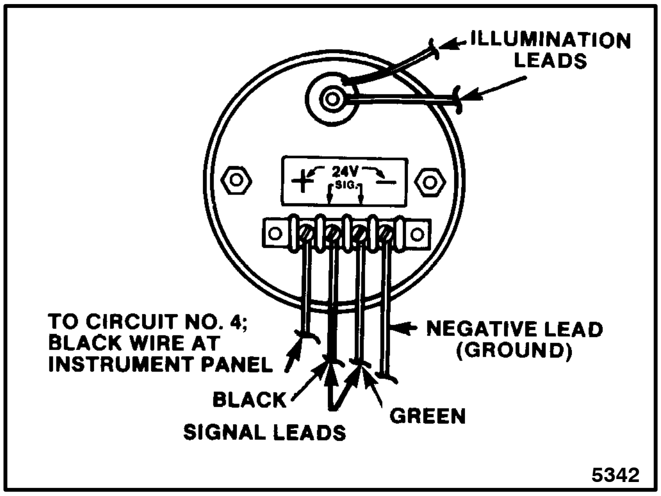

Figure 1. Electronic Speedometer Connections

The most common signal source is a magnetic sensor. It operates with a permanent magnet built into the sensor, providing a magnetic field at the nose of the sensor. As a ferrous material (bolt) passes in front of the sensor, the magnetic field is disrupted generating a voltage in a coil of wire wrapped around the magnet (Figure 3)The frequency of this voltage is directly proportional to the number of bolts passing in front of the sensor in a given period of time.

INSTALLATION OF SPEEDOMETER

The electronic speedometer fits in the SAE standard $3^3/_8$ inch (85.7 mm) panel cutout and is easily installed and secured with the U-clamp (supplied with each unit). The wire used to connect the sender to the head should, for durability, be no smaller than 20 gauge (preferred).

1. Connect speedometer and sensor leads (Packard connector).
2. Connect the terminal marked "+" to Circuit #4 - black wire at the instrument panel.
3. Connect the terminal marked "-" to the stud marked "Ground" at the instrument panel.
4. Connect the red lampholder lead to the stud marked "Illumination" at the instrument panel.
5. Connect the black lampholder lead to the stud marked "Ground" at the instrument panel.

INSTALLATION OF MAGNETIC SENSOR

Refer fo Figure 2.

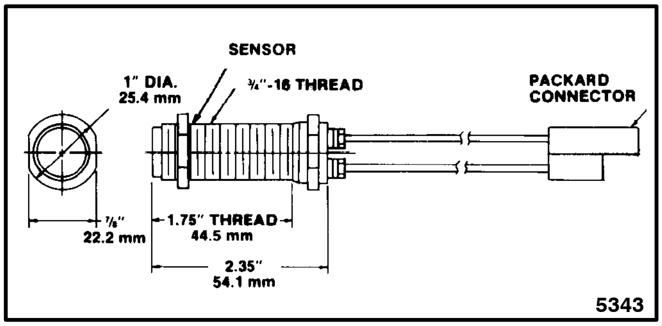

Figure 2. Electronic Speedometer Sensor and Lead

1. Clean area around mounting hole.

2. Turn magnetic sensor clockwise until it bottoms out on the bolt head.

3. Turn sensor counterclockwise until air gap between sensor and bolt head is 0.048-0.062 inch (1.22-1.57 mm).

4. Tighten the jamnut against the housing bracket.

NOTE: Sensor must not rotate.

5. Connect sensor leads to instrument leads (if not already connected).

TROUBLESHOOTING

Properly installed instruments may indicate momentary needle jump each time the key switch is turned on.

Electrical Checks:

1. Check hookup and wiring to assure the connections on the terminal strip are made.
2. Check to ensure any uninsulated lead portions are not touching.
3. Follow the signal wires to verify that they are properly connected to the signal source.
4. Verify that the "+" and "-" leads are securely connected.
5. Check fuses.
6. See if the wires have frayed insulation.
7. Check for wire shorts.
8. Check for proper sensor installation. Turn sensor clockwise until it bottoms out, then turn counterclockwise until air gap between sensor and bolt head is 0.048-0.062 inch (1.22-1.57 mm).
9. Check coil resistance with ohmmeter. It should register 160 ohms ±5%. (Disconnect sensor from instrument before connecting ohmmeter.)
10. Remove sensor and connect to AC voltmeter. Move ferrous metal in front of sensor. If the voltmeter shows any movement, the sensor is operating properly.

NOTE: The Dixson Tester (Model CL1101) is available from Dixson, Inc., Grand Junction, CO (to test the head only).

ALTERNATE ELECTRONIC SPEEDOMETER

A Sigmanetics brand electronic speedometer may be installed in place of the Dixson electronic speedometer (Figure 2). The speedometer head is installed on the left side of the instrument panel. A single sensor is mounted on the backing plate on the left front wheel. Also four bolts are mounted 90 degrees apart on the brake drum.

TESTING

A tester is available from Motor Coach Industries, Service Parts Division (Winnipeg, Manitoba, or Newcastle, Ontario, Canada) or Universal Coach Parts, Inc. (Des Plaines, Illinois) for checking speedometer readings on MCI series coaches with the takeoff from the left front wheel.

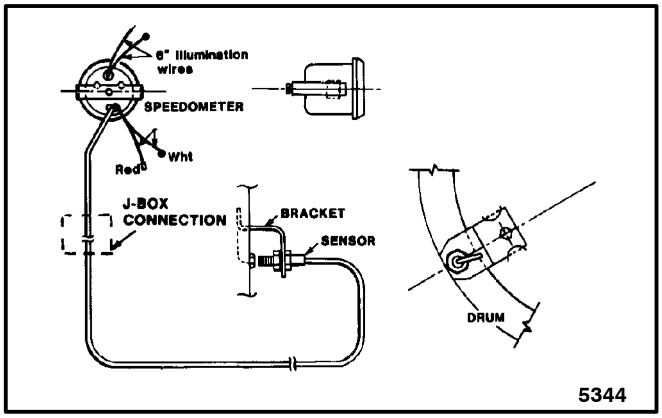

Figure 3. Alternate Speedometer Installation

The tester has a light emitting diode (LED) on face plate. The LED flashes at a set frequency when calibrating the speedometer. This will allow the operator to know that the tester is working in the event the speedometer under test is bad.

TESTING PROCEDURES WITH HZ60LM TESTER

Refer to Figure 4.

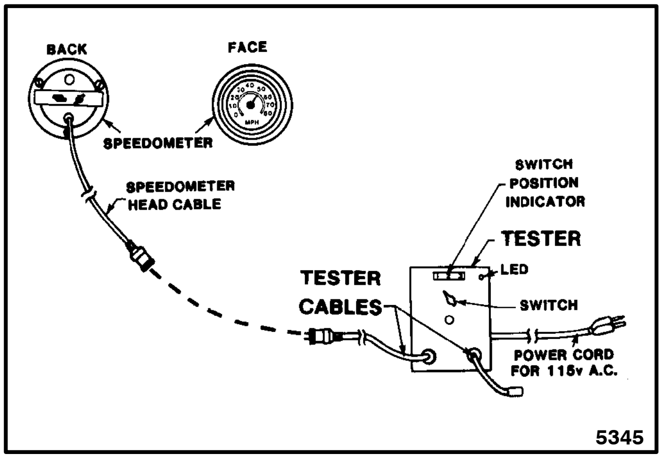

Figure 4. Checking Speedometer on Bench (Sigmanetics)

1. Set the three-position switch to position 2.
2. Disconnect the pickup cable from the speedometer.
3. Connect the tester cable to the speedometer.
4. Make sure there is power (24V) to the instrument under test.

5. Plug the power cord from the tester into a wall socket, making sure the power is 110VAC, 60 Hz.

6. The instrument on test should register $56^1/_4$ Mph (90 km/h). If any part of the needle touches the correct division, the meter is within specifications.

7. If the unit is not operating accurately, it should be replaced.

CHECKING SPEEDOMETER IN COACH

To check units that are installed in coaches, proceed as follows:

Disconnect the speedometer head from the pickup cable. Leave other wiring connected. A 110VAC, 60 Hz power supply is required to operate the tester. Proceed with steps 1 thru 6 above. A tolerance the width of the speedometer needle is allowed. If the above reading is not within, or close to this range, units must be replaced.

CORRECTING SENSOR GAP

The gap between the sensor and bolts is set at the factory and should not require adjustment. However, if the speedometer does not register at low speeds or reads double at high speeds, the following procedures should be followed to correct the situation.

1. Make sure all four bolts pass approximately the same distance under the sensor pickup.

2. Start with a gap between the sensor pickup and bolt heads of about $1/_{16}$ inch (1.5 mm).

3. Watch the speedometer needle on the instrument panel as the coach slows down. The needle will begin to oscillate (shake) as the speed decreases. When the indicated speed drops to approximately 7 to 5 mph (12 - 9 km/h), the needle should suddenly drop to zero. If it continues to display a reading below 5 mph (9 km/h), the gap is too narrow and should be widened slightly. If this is not done, the needle may oscillate and become erratic at highway speeds.

Conversely, if the needle drops to zero at 15 mph (23 km/h) or more, the gap is too wide and should be narrowed slightly.

4. After adjusting the gap, always check the speedometer reading to make sure the gap is increased or decreased correctly.

SPECIFICATIONS

	Mechanical
BEZEL	Electropolished stainless steel standard.
CASE	Zinc-plated steel with yellow chromate.
DIMENSION	SAE 3.38” (85.73 mm) standard size panel hole.
POINTER	White.
SCALE	0-80 mph/0-120 km/h standard.
WEIGHT	17.5 oz. (496 gm) nominal.
	Electrical
ACCURACY	Meets or exceeds SAE J1226, ±2% full scale.
FREQUENCY RANGE	60-29,500 Hz standard.
LIGHTING	2-wire socket - 1864 bulb.
POLARITY	Will work with negative ground systems. Reverse polarity protected.
START PROTECTION	Withstands 24 VDC external boost start for 30 minutes.
SUPPLY VOLTAGE	24 VDC - operating range 22V min. to 32V max.
	Environmental
OPERATING TEMP.	-40° to +85°C; exceeds SAE J1226.
SEALING	Watertight to +8” of mercury.
MAGNETIC SENSOR	
Air Gap Coil Resistance Dimensions	0.048-0.062 160 ohms ± 5% 2.35” (59.69 mm) long, 1.75” (44.45 mm) thread length, ⅜”-16 UNF
Operating Temperature Output Voltage Induction Weight	-40 to +204°C. See figure 7-55. 50 mh 4.0 oz. (113 gm) nominal

SECTION 7F

ALARMS AND SIGNALS

CONTENTS OF THIS SECTION

SUBJECT PAGE
Alarm Buzzers 7F-1
3N124 Triple Function Protective Device 7F-1
Turn Signal Flasher 7F-3
Horns 7F-3
Specifications 7F-4

ALARM BUZZERS

The alarm system buzzers are mounted in a sealed, external junction box in the left-hand corner below the driver's window. The buzzers are for low air, hot engine, low water, and low oil pressure conditions.

NOTE: Activate each circuit and adjust buzzer for desired sound. To increase sound, turn adjusting screw clockwise; counterclockwise to decrease. Refer to Figure 1 for adjusting screw.

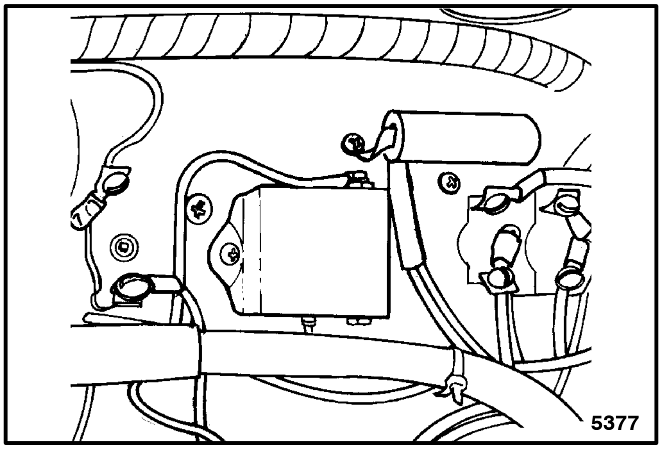

Figure 1. Alarm Buzzer

The manufacturer's specified range is between 65 and 75 decibels. The factory setting is 75 decibels.

3N124 TRIPLE FUNCTION PROTECTIVE DEVICE

This device has the following internal protective features.

1. A self-healing current limiter in the starter circuit.
2. A heavy duty self-healing current limiter in the starter ready light circuit.
3. A diode in the alternator pulse input.

The above features prevent negative pulses from entering the integrated circuit of the device.

4. A transorb in the 24-volt input which prevents damaging high voltage transients from entering the circuit board.
5. A Zener diode in the starter wire which limits the voltage to 18 volts in the circuit when the starter switch is activated.

NOTE: This device is not present on coaches which have the optional Thermal Time Delay Relay.

All three functions are contained it a unit which is mounted in the rear junction box. Refer to the appropriate Series Model rear junction box layout drawings which are included in the "Wiring Diagram Book". Also refer to the 3N124 Triple Function Protective Device wiring diagram.

A description of each of the three functions follows.

6. **High Voltage Cutout Function** - One section of the Triple Function Protective Device uses a relay to interrupt power to the alternator field relay in the event of a high voltage condition. The interrupt circuit is between the two blue wires coming out of the unit. The contact capabilities are 3 amps DC, which is more than adequate to run the field relay. The relay in the 3N124 is normally relaxed and the contacts are normally closed. In the event the voltage exceeds 30.5 volts for a period of time in excess of 1.0 second the relay will energize, opening the contacts and interrupting the alternator field relay. The 3N124 has a self-holding feature so that the interruption will continue until the driver shuts off the

master switch and turns it on again. If the high-voltage condition still exists, the unit will trip again. The driver will be aware of the fact because the alternator discharge light will be turned on at the driver's instrument panel and in the engine compartment. The 1.0-second time delay will eliminate false tripping because of momentary transients caused by turn signals, air conditioners, or other circuit interruptions. Under normal circumstances this relay will never be energized; therefore, it draws no power from the coach supply system until an overload condition occurs. If the alternator discharge light should come on, it would indicate a malfunction in the electrical system which should be corrected by maintenance personnel. The driver should cycle the master switch in an attempt to clear the malfunction in case the high-voltage condition is only momentary. The 1.0-second time delay provides protection from transients, but will still save light bulbs, electric motors and dashboard instruments from failures due to a high-voltage condition.

7. **Low Oil Pressure Switch Interrupt Function** - The function of this element is to prevent the low oil pressure switch from shutting down the engine before oil pressure can be established immediately after engine start-up. The interrupt contacts have 3-amp capabilities and are in the black wires coming out of the unit. These wires should interrupt the low oil pressure switch circuit and are connected in series with that switch. Internally the relay that controls this interrupt is normally unenergized and the contacts are normally closed. When the starter is energized, so also is the interrupt relay, thus opening the low oil pressure switch line. The relay remains energized (and the contacts open) for the duration of the cranking cycle and for 10 seconds afterward. The relay in this element is energized only during the cranking cycle and for 10 seconds afterward, at which time it returns to the relaxed or unenergized state. The only time it draws power is during the cranking cycle and for 10 seconds afterward. Starting a new cranking cycle (initiated prior to the time that the 10-second period from the first cranking cycle has expired), the time delay will be rearmed and a new 10-second cycle will begin at the conclusion of the cranking period.

8. **Starter Protector Function** - The function of this portion of the device is to prevent the starter from being activated if the engine is turning. This element uses the R-1 lead output of the alternator to sense engine movement. If the engine is turning, no matter how slowly, it will prevent the starter solenoid from being activated; however, it will still allow the override features of the starter switch to function. It does not interrupt the override for high engine temperatures or low oil pressure. Neither will it interrupt the starter cycle as soon as the engine begins to crank.

This relay remains unenergized until the master switch is turned on. At that time the relay is energized, allowing the starter switch to supply power to the starter solenoid relay. It remains energized and the starter circuit armed until the driver energizes the starter switch and throughout the cranking cycle. When the starter button is released and the engine is turning, the relay de-energizes (interrupting the starter solenoid circuit) and remains in this condition as long as the engine is turning, no matter how fast or how slowly. The instant the driver releases the starter switch after cranking, the starter is prevented from being re-engaged until the engine comes to a complete halt. This is accomplished by a relay with contact capabilities of 3 amps. Under normal operating conditions, the circuit draws no power from the coach, except momentarily between the time the master switch is energized and the engine is started.

The starter protector element of the 3N124 device is connected to a warning light on the driver's instrument panel. This light, when illuminated, tells the diver that the starter solenoid relay is armed. Under normal operating conditions, the light comes on when the master switch is turned "ON" and will remain on until engine start-up has been accomplished.

Should the warning light remain illuminated after the engine has started, or if it comes on during coach operation, the driver is warned of a fault in the system and that the starter solenoid relay is armed. A broken R-1 lead or a faulty relay would cause the light to come on. Either of these malfunctions would prevent a signal being sent to the starter protection element that the engine is turning over. Under certain operating conditions, such as attempting to crest a long grade without engine shutdown, the driver might press the starter switch. Before pressing the starter switch the driver should be certain that the warning light is not illuminated. He must not use the override feature of the starter switch if the warning light is on. If he does so and the engine is turning over, serious damage to the starter or engine flywheel can result.

TESTING OF 3N124 TRIPLE FUNCTION PROTECTIVE DEVICE

To test the Triple Function Protective Device after it is installed in the coach, proceed as follows:

1. With the battery disconnect switch in the "ON" position, turn the master switch "ON" at the driver's instrument panel. The "Starter Alert" telltale light at the dash should be lit. This indicates the starter is armed and ready.

2. To test the starter protection feature, start the engine and DO NOT release starter switch (or keyed ignition switch). The starter should “drop out” almost immediately following engine start-up and the telltale light should go out.

CAUTION

If the telltale light remains on following engine start-up, release the starter switch (or keyed ignition switch) immediately and DO NOT perform step 3. (No Starter Protection)

3. With the engine at idle, release the starter switch and attempt to re-engage the starter. There should not be any response.

4. Ground the left-hand “Hot Engine” alarmstat and hold the starter switch prior to engine shutdown. The engine should continue to run without starter engagement as long as the starter switch is held in the “ON” position (starter bypass feature).

5. To test the Low Oil Pressure Switch interrupt feature, ground circuit #60 at the 3-pound oil sender while the engine is running. The engine will shut down following approximately a 10-second delay.

6. To test the Overvoltage Protection Feature, place a volt-ohmmeter between “A1” and ground at the regulator (50-volt scale).

7. With the engine running at fast idle (no load), SLOWLY move the adjustment screw at the regulator clockwise and observe the voltage reading. The alternator should “drop out” between 30-31 volts.

CAUTION

If the alternator does not “drop out” at 31 volts, DO NOT proceed any further. (No Overvoltage Protection.) Readjust the regulator to 27.2 volts.

8. If the alternator does “drop out,” turn the regulator adjustment screw back (counterclockwise) approximately ½ turn and turn the master switch off at the dash.

9. Start the engine and adjust the regulator back to 27.2 volts.

10. If any one of the above test steps fails, replace the defective unit.

TURN SIGNAL FLASHER

The turn signal flasher, located in the front junction box, is a solid-state-type flasher (Figure 2). The flasher contains a clapper, which produces an audible sound, to alert the driver when the turn signal had been left on.

HORNS

DESCRIPTION

The coach is equipped with two 24V electric horns located in the left-hand front service compartment. The horn tone is created by a vibrating diaphragm which causes an air column to vibrate (Figure 3).

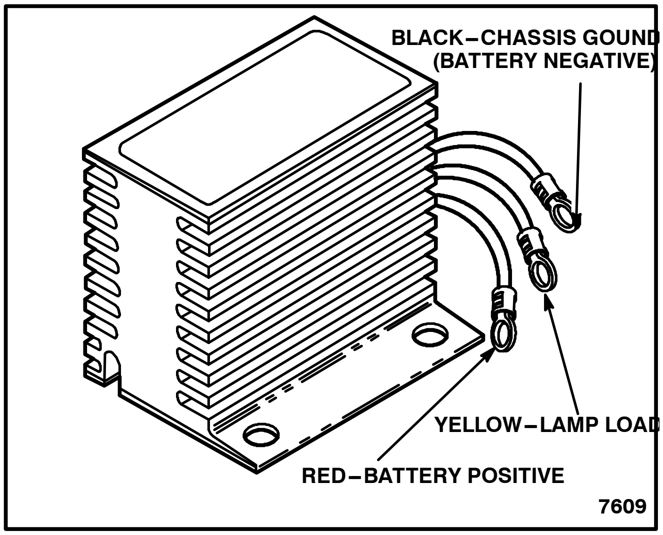

Figure 2. Kysor Solid State Flasher

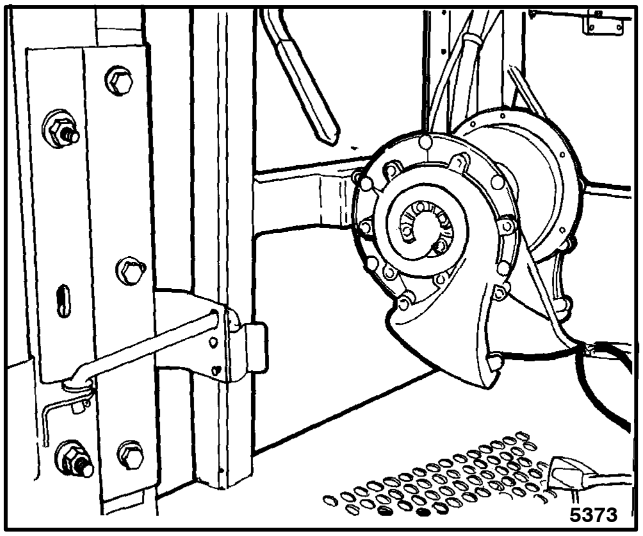

Figure 3. Horns

OPERATION

The horns are operated by pressing a button in the center of the steering wheel or by using the electric foot switch. When the optional air horns are used, a foot operated air valve is mounted beside the electric foot switch.

MAINTENANCE

The only maintenance required is an electric current adjustment of the adjusting screws on the electric horns. On each system one horn produces a high note and the other a low note.

SPECIFICATIONS

ALARMSTAT (NON-ADJUSTABLE TYPE)

Manufacturer	Kysor
Model Number	1002-05511-34
Part No.	8G-28-7
Contact Points Close At	210°F (99°C)
Model Number (Optional)	1002-05511-36
Part No.	[8G-28-8
Contact Points Close At	20°F (104°C)

LOW AIR PRESSURE SWITCH

Manufacturer	Stewart-Warner
Part No.	7J-13-299
Terminals	3
Circuit	SPDT
Maximum Operating Pressure	500 psi
Operation	Contacts set to transfer at 75 ±5 psi (max) increasing pressure Contacts reset at 75 ±10 psi as pressure decreases
Setting Tolerance	100 psi (+0. −10 increasing), 70 psi (±5 decreasing)

SECTION 7G

BATTERIES

CONTENTS OF THIS SECTION

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Checking Electrolyte Specific Gravity 7G-2
Battery Charging 7G-2
Causes of Battery Failure 7G-3
Testing 7G-3
Booster Starting & Charging 7G-4
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Battery Equalizer 7G-5
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BATTERY DISCONNECT

Main battery disconnect switch(es) are provided to shut off both 12/24 volt electrical supply from the batteries. The dual 12/24 volt switch assembly is panel mounted above the batteries and can be reached by opening the battery compartment or switch access door. To disconnect the batteries pull the switch down to the "OFF" position (Figure 1).

CLEANING AND INSPECTION

CAUTION

Battery connections must be maintained as shown on the decal inside the battery compartment. Failure to observe this caution will result in damage to coach electrical equipment.

The external condition of the battery and battery cables should be checked periodically. Keep the top of the battery clean and the battery hold-down bolts tight, but take care that the hold-down bolts do not place undue strain on the battery case. Cable clamp bolts must be kept tight to ensure proper electrical connection between the battery posts and the cable clamps.

If a build-up of acidic residue occurs on the battery surface, the posts, cables or on compartment surfaces, apply a solution of baking soda and water with a brush to neutralize and remove it. Flush all affected areas with clean water and dry thoroughly.

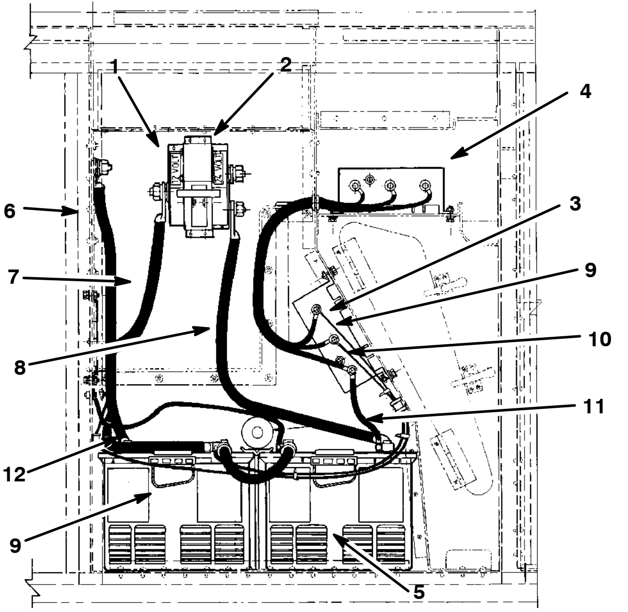
NOTE: Keep the battery vent plugs securely in place to prevent soda solution and/or water from entering the cells.

All paint bubbles on compartment surfaces must be scraped to bare metal and repainted with No. 701 Red-Con-Treat paint. Inspect all grommets and cable hangers to make sure proper protection is afforded the battery cables.

If the battery posts or cable clamps are corroded or pitted, they should be cleaned separately with soda solution and cleaned with a stiff wire brush. Stubborn deposits may require careful removal with a knife.

After all surfaces are clean and dry, reconnect the cables to the battery posts observing proper polarity. Tighten the cable terminals securely onto the battery posts. Apply a liberal coating of neutral dielectric lubricant on the cable terminals and battery posts to prevent the build-up of acid deposits.

The electrolyte level in the battery cells should be checked at least every week or 5,000 miles (8,000 km). The check can be facilitated by using a mirror and flashlight. After removing the cell vent plugs, hold the mirror over the cell to be checked and direct the flashlight beam into the mirror to check the electrolyte level. If the electrolyte level in any cell is low, add sufficient distilled water to bring the level up to the bottom of the cell vent well.



1. 12V CIRCUIT DISCONNECT SWITCH
2. 24V CIRCUIT DISCONNECT SWITCH
3. EQUALIZER 50 AMP
4. EQUALIZER 50 AMP
5. BATTERIES
6. GROUND CABLE
7. 12V SWITCH CABLE
8. POSITIVE CABLE
9. BATTERY EQUALIZER GND
10. BATTERY EQUALIZER JUMPER
11. EQUALIZER POWER
12. FEED JUMPER

7601

Figure 1. Battery Disconnect Switches

⚠ CAUTION ⚠

Use only distilled water in battery cells to prevent the introduction of impurities in the batteries. Do not add any substance to the electrolyte except distilled water. Do not overfill the cells since electrolyte expands during battery use.

CHECKING ELECTROLYTE SPECIFIC GRAVITY

The minimum permissible specific gravity of the electrolyte in each battery cell is 1.200. As can be seen in the following table, electrolyte with this specific gravity will freeze at a temperature of -17°F (-27°C).

Before checking the specific gravity of the electrolyte in any cell, first add distilled water if necessary to bring the level up to the required point. If substantial amount of distilled water is added to any cell, the battery should be charged before the specific gravity is checked. Refer to Battery Charging below.

Use a temperature-correcting hydrometer to determine the specific gravity of the electrolyte in each battery cell. Specific gravity of any cell should not be less than 1.200. If any cell specific gravity tests below 1.180, the battery should be charged according to the instructions below, and the specific gravity rechecked.

SPECIFIC GRAVITY	FREEZING TEMPERATURE (DEG) F	(DEG) C
1.100	+18	-8
1.120	+14	-10
1.140	+8	-13
1.160	+2	-17
1.180	-6	-21
1.200	-17	-27
1.220	-31	-35
1.240	-51	-46

If there is a difference in specific gravity of 50 or more from the highest to the lowest cell, for any single battery after charging, the battery requires replacement.

⚠ CAUTION ⚠

Batteries should be replaced only in matched pairs. Only batteries of the required specifications are to be used. Refer to the specifications listed at the end of this section.

BATTERY CHARGING

Recommended battery charging is for a period of 24 hours at a rate of 12-15 amps, at 15 volts. The battery is considered fully charged when no change in charging rate (amperage) is noted for three consecutive readings, one hour apart.

Highly sulfated batteries may require an initial charging rate at 16 or 17 volts in order for charging current to begin flowing through the battery. After two minutes of initial charge at increased voltage, reduce the voltage to the nominal 15 volts.

⚠ CAUTION ⚠

Do not allow electrolyte temperature to exceed 125°F (52°C) during charging. If the temperature rises, decrease charging voltage.

CAUSES OF BATTERY FAILURE

Besides the breakdown of internal battery components, battery failure may be caused by a faulty electrical component associated with the coach electrical system, or a condition existing within the electrical system. Such causes include the following:

A. A defect in the alternator or voltage regulator, or a faulty connection (high-resistance or open) associated with these components.

B. Defective starter motor or the excessive use of accessories over long runs.

C. Defective electrical accessories which tax the alternator beyond its capacity to produce charging current.

D. Dirt, electrolyte and/or acidic deposits on the top surfaces of the batteries.

In addition to the above factors external to the batteries, which may contribute to battery failure, the following causes of battery failure are within the batteries themselves.

A. Hardened battery plates which result from the battery being in a low state of charge over an appreciable period of time.

B. Shorted cells, loss of active material from plates. This is a normal process of internal “wear” of the battery which takes place during the active life of the battery. Proper maintenance of the battery and the coach electrical system will extend the useful life of the battery to its intended length of service.

TESTING

RECOMMENDED TESTING EQUIPMENT

The following items are recommended to perform the tests of electrical equipment, including batteries:

1. One 0-500 amp external shunted ammeter to indicate alternator output.
2. One 0-15 ammeter to check field coil circuit.
3. One 10-amp circuit breaker to be placed in series with the 15-ammeter when checking the field coil circuit.
4. One 0-30V voltmeter.
5. One 50 mV external meter for the 500-amp shunt.
6. One temperature-corrected battery hydrometer.
7. Tube of neutral dielectric lubricant.
8. Baking soda, jar and small paint brush.
9. Battery terminal and post cleaner.
10. Wire brush.
11. Corrosion-resisting felt washers to be placed over the battery posts prior to cable clamp installation.

HIGH RATE DISCHARGE TEST

⚠ CAUTION ⚠

DO NOT perform this test on a battery suspected of being in a discharged state. Specific gravity must be above 1.230 before this test is conducted. After slow charging a battery, allow the battery to stand 8-10 hours before conducting this test.

1. Battery must be installed in coach. Place the voltmeter range selector so as to measure 10VDC.
2. Check the voltage drop between the grounded (negative) battery terminal and vehicle frame. With the starting motor turning over, the voltage reading should be less than 0.3 volts. If more, there is excessive resistance in the circuit.
3. Check the voltage drop between the positive terminal of the battery and the starting motor terminal stud while the starting motor is turning over. If the reading is more than 10 volts, the resistance is excessive.
4. Check the voltage drop between the starting motor housing and the coach frame. If over 0.2 volts, the resistance is excessive.

BATTERY TEST

Since the primary purpose of the coach batteries is to supply cranking power for the engine, a cold cranking performance battery test is the most meaningful test to determine the condition of the batteries. It is based on the requirement that a 12V automotive battery be able to maintain 7.2 volts for a 20-second period while turning over an engine at 0°F (-17°C).

The following procedure will be useful in determining the condition of the batteries while they are installed in the coach. The batteries are assumed to be in satisfactory condition if the test readings agree with those in the table following the procedure.

NOTE: Test results will not be valid if the starter motor is defective or if there are high-resistance connections in the starter motor circuit.

To test the batteries, follow this procedure:

1. Place the engine run switch in the engine compartment in the “OFF” position to prevent the engine from starting.
2. Place a voltmeter (50-volt scale) across the battery terminals.
3. Turn the engine over for 15 seconds and record the voltmeter reading at the end of the 15-second test period. Refer to the following table for voltage readings to determine the relative condition of the batteries.

TEMPERATURE	MINIMUM TEST VOLTAGE
70°	19.2
60°	18.8
50°	18.6
40°	18.2
30°	17.4
20°	16.4
10°	15.8
0°	14.4

A defective battery condition is indicated if the voltage reading after 15 seconds of engine cranking is less than the minimum test voltage for the appropriate ambient temperature. The above procedure requires batteries to be fully charged, cells to be filled to capacity with electrolyte of correct specific gravity. These subjects are discussed above.

BOOSTER STARTING & CHARGING

⚠ CAUTION ⚠

Any procedure other than the following could result in:

1. Personal injury caused by electrolyte squirting out of the battery vents.

2. Personal injury or property damage due to battery explosion.

3. Damage due to the charging system of the booster vehicle or of the immobilized vehicle.

Do not attempt to jump start a vehicle having a frozen battery because the battery may rupture or explode. If a frozen battery is suspected, examine all fill vents of the battery. If ice can be seen, do not attempt to start the vehicle with jumper cables as long as the battery remains frozen. Both the booster battery and the discharged battery must be treated carefully when using jumper cables. Follow EXACTLY the procedure outlined below, being careful not to cause sparks.

CONNECTING BOOSTER CABLES

1. Set parking brake, turn “OFF” lights, heater and other loads.

2. Remove vent caps from both the booster and the discharged batteries. Lay a cloth over the open vent wells of each battery. These two actions help reduce the possibility of explosion which is always present when connecting a “live” booster battery to a “dead” battery.

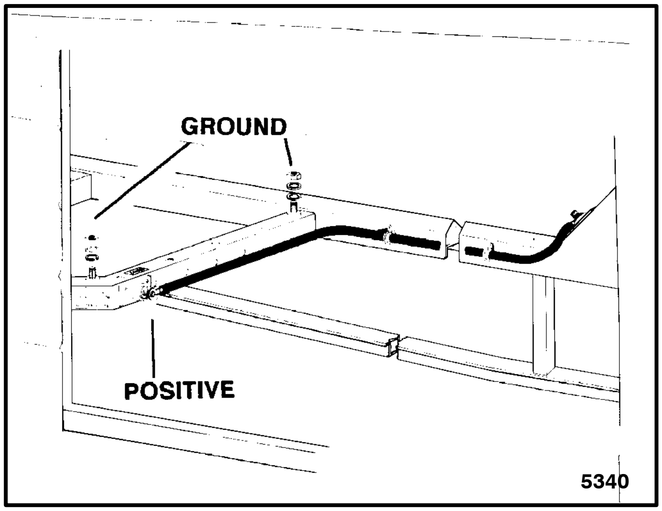


Figure 2. Jump Start Connections

3. Attach one end of one jumper cable to the positive terminal of booster battery (identified by a red color “+” or “P” on the battery case, post or clamp), and the other end of the same cable to the post on the side of the channel on the front of the A/C compressor base (Figure 2) A rubber boot covers this post during normal coach operation, and must be removed when attaching booster cable.

Do not permit vehicles to touch as this could establish a ground connection and counteract the benefits of this procedure.

4. Attach one end of the remaining negative (–) cable to the negative terminal (black color “-” or “N” of the booster battery, and the other end to the ground stud on the top of the air compressor front mounting rail (Figure 2). Take care that clamps from one cable do not inadvertently touch the clamps on the other cable.

DISCONNECTING BOOSTER CABLES

1. Take care that clamps from one jumper cable do not inadvertently touch clamps on the other jumper cable, disconnect jumper lead from ground stud on the vehicle being started.

2. Remove one end of negative (-) jumper cable from the booster battery.

3. Remove the end of the remaining jumper cable from the post on the side of the front mounting rail of the A/C compressor, then remove the other end of the same cable from the positive terminal of the booster battery. Secure the rubber boot over the post on the A/C compressor mounting rail.

4. Remove cloths from open vent wells of each battery. Discard cloths as they may have corrosive acid on them. Install vent caps on both the booster and the discharged battery.

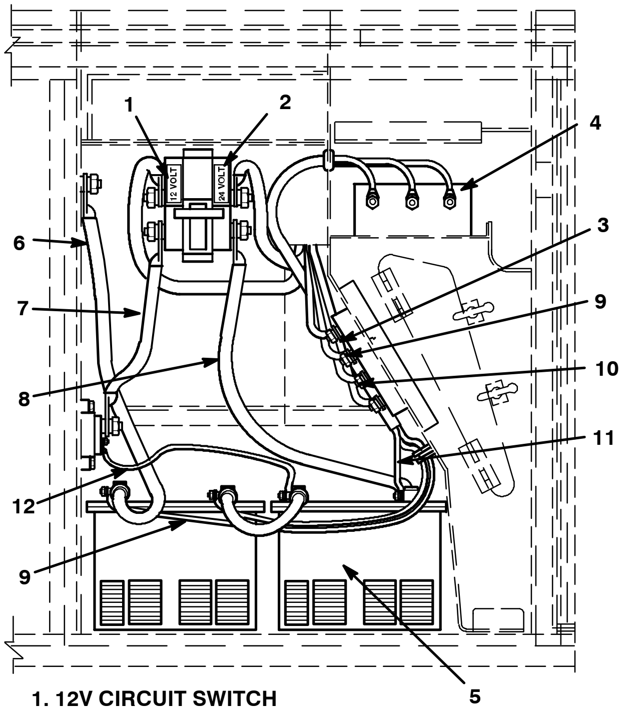
AUXILIARY 12-VOLT POWER

12-VOLT POWER (40-AMP LIMIT)

Twelve-volt equipment with a combined current draw of up to 40 amps can be installed with the 12-volt power system (Stud #55). The system is basic on all coaches with 12-volt exterior lights, DDEC II and III and/or ATEC.

The 12-volt auxiliary power system installation will feature either one 100-amp or two 50-amp battery equalizer(s) and incorporates a (40-amp) circuit breaker protection.

An installation and wiring layout diagram is included in the diagrams and schematics located in the later pages of this section.



1. 12V CIRCUIT SWITCH
2. 24V CIRCUIT SWITCH
3. SINGLE VANNER EQUALIZER SYSTEM
4. EQUALIZER
5. BATTERIES
6. GROUND CABLE
7. 12V SWITCH CABLE
8. POSITIVE CABLE
9. BATTERY EQUALIZER GND
10. BATTERY EQUALIZER JUMPER
11. EQUALIZER POWER
12. FEED JUMPER

C0048

Figure 3. Battery Equalizer & Circuit Breaker

BATTERY EQUALIZER

DESCRIPTION

The battery equalizer system may feature either one 100-amp or two 50-amp battery equalizer(s) (Figure 3)

The battery equalizer circuit is protected by a (105 amp) manually resetting breaker. This system maintains the voltage balance and charge acceptance rate of each battery to anywhere from 0.1-0.01 volt under a light load and 0.5 volt with a full load.

With this system, it is not necessary to replace both batteries if one of them becomes defective; the equalizer system will maintain a balance between the old and new battery.

NOTE: When replacing only one of the batteries, install the new battery in the grounded position (at the rear of the battery compartment).

OPERATION

When the voltage of the grounded battery ("A") is higher than that of the ungrounded battery ("B"), the equalizer is in a standby mode. When battery "A" decreases in voltage to just below that of battery "B",

the equalizer turns on and transfers just enough power

from "B" to "A" to satisfy the load and to maintain an equal voltage and charge in both batteries.

The following three operational conditions will normally be encountered; the equalizer will function as described.

1. A 24V load is present; no 12V load is present. The system will operate as a normal 24V system would, whether the alternator is on or not and the equalizer is in a standby mode. It will make minute adjustments to keep the batteries in balance.
2. Both 24V and 12V loads are present, and the alternator is off. Both batteries will discharge at the same rate even though there is an unequal load. (See operation above.)
3. Both 24V and 12V loads are present and the alternator is on. The alternator will provide 24Vs just as though there were no equalizer or 12V load in the system. The equalizer transfers the 24Vs to 12Vs for the load, plus maintains battery balance.

SAFETY FEATURE

The 12V output of the equalizer is currently limited, making it short circuit proof and virtually indestructible. In the unlikely event of a failure of the unit, battery "A" will sustain the load for a limited length of time and about the same condition would occur as if there were a battery failure.

TESTING THE EQUALIZERS

The following procedure provides a test to determine if the equalizer is working properly. The test equipment that will be required is one sealed beam 12V headlamp and two jumper wires.

1. Disconnect the ground lead from the equalizer ground stud.

2. Connect one lead of the test seal beam headlamp to the 12-volt stud on the equalizer. Connect the other lead on the sealed beam headlamp to the ground stud on the equalizer.

3. If the equalizer is operating properly, the headlamp will glow steadily.

4. If a malfunction exists in the equalizer, the light will either glow steadily and then go out, or will not illuminate at all.

5. After the test is complete, reconnect the battery ground lead to the equalizer ground stud.

TROUBLESHOOTING

1. Carefully remove the ground (GND) cable from the Equalizer. DO NOT allow this cable to touch any other connection on the Equalizer because the other terminals are connected to the batteries.

2. Make sure there is approximately 12Vs between the +24 and +12 terminals of the Equalizer by momentarily connecting the two terminals of a 12V light (headlight) to the +24 and +12 terminals of the Equalizer. The light should light and stay lit.

3. Next, connect the same 12V load between the +12 and GND terminals of the Equalizer. The lamp should light and stay lit. If the light does not light, or lights then goes out, the Equalizer requires repair.

4. Further verification may be made by measuring the voltages on the Equalizer terminals. Be certain that the lamp used earlier is connected between +24 and +12 terminals. Note this reading.

5. Measure the voltage from the +12 terminal to GND. Note this reading.

6. Compare the two readings by subtracting the +12 to GND reading from the +24 to +12 reading. A properly functioning Equalizer is one where the difference is between -0.5 and +0.13 volts. For example, the +24 to +12 reading might be 12.85 volts. The +12 to GND reading might be 12.75 volts. This Equalizer would be functioning properly with a 0.10 difference (12.85 minus 12.75 volts) which is within specs.

SPECIFICATIONS

BATTERIES (24-VOLT SYSTEM)

Ampere Hour Capacity at 20 Hour Rate	225
Number of Plates Per Cell	29
Separators	Plastic
Reserve Capacity	393 mins.
Cold Cranking At 0°F (-18°C)	975 amps
Weight Dry	104 lbs. (47 kg)
Weight Wet	146 lbs. (66 kg)
Acid to Fill	16.2 Qts. (U.S.)(15.4 liters)
Number of Batteries	2
SAE Number	8D
Grounded Terminal	Negative

SECTION 7H

SOUND AND VIDEO SYSTEMS

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 7H-1
Components 7H-1
Operation 7H-2
Maintenance 7H-4
Specifications 7H-12

GENERAL DESCRIPTION

A public address system is basic on all 102D series coaches. The PA is installed to the right of the driver on glove box panel, with its power amplifier mounted in the front junction box. An optional back-up public address system and/or installation is available along with optional microphone and their optional locations.

In addition to the public address systems, options for AM/FM stereo radio and cassette player and video system with monitors and digital processor controller may be featured.

Each service module mounted to the underside of the parcel racks contains a 45-watt speaker. The speakers are wired in stereo and are powered by the amplifier.

Information about each of these systems and operating instructions for some of the equipment are listed in this section. Schematics and installation diagrams pertaining to the PA and the audio/video entertainment systems can be found in this sub-section and sub-section 7J.

COMPONENTS

PUBLIC ADDRESS (MAIN SYSTEM)

The main (glove box mounted) PA system is composed of a volume/tone preamp/power control unit, power amplifier, microphone with mount bracket and microphone jack located in RH driver's console.

PUBLIC ADDRESS (BACK-UP SYSTEM)

The back-up (LH dash mounted) PA system is composed of a volume/tone preamp/power control unit, back-up power amplifier, microphone with mount bracket and mic jack located adjacent to control unit.

The PA microphone may be hand held or a boom-type. Jacks for microphone(s) may be installed at the following locations.

A. The RH driver's console.
B. The LH side of steering column on dash.
C. The front of the right-hand parcel rack.
D. The rear of the left-hand parcel rack.

AM/FM RADIO & CASSETTE

The optional glove box mounted audio system is composed of a stereo AM/FM radio/cassette unit and roof mount antenna (Figure 1). The unit is connected to the public address system's power amplifier. Early model radios (R-650, R-655, CQ-R45 & CQ-R35) are wired thought the master run or keyed ignition switches, and have a battery back-up arrangement to retain memory function. Later model (CQ-E15) is wired direct to the battery via the front junction box (Stud 24). Models CQ-R45, CQ-R35 & CQ-E15 incorporate switching controls for the optional compact disc (CD) player.

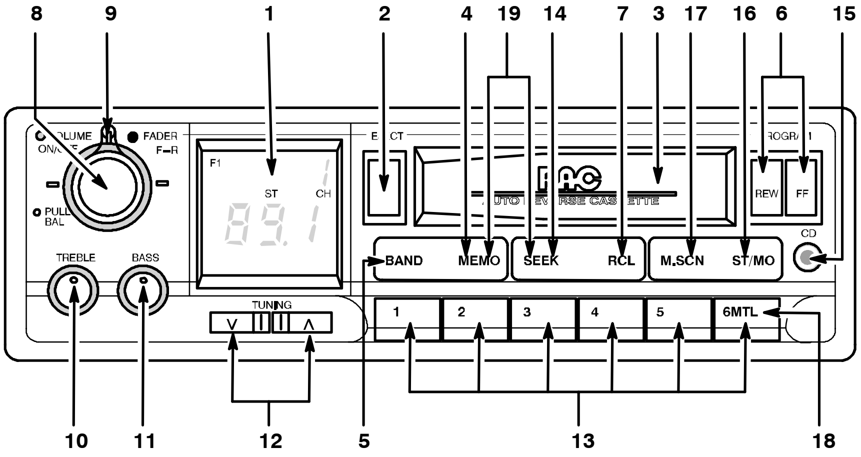
NOTE: Radios without battery back-up were installed effective with unit #49048.

VIDEO ENTERTAINMENT (SYSTEM 2000)

The system 2000 is a new generation of audio/video entertainment designed exclusively for tour coach operations. A complete system will incorporate the following equipment.

A. A specially designed 70 watt per channel RMS amplifier. capable of driving up to twenty-six, four ohm speakers.

B. Up to six, custom designed ten inch color monitors which incorporate a unique anti-theft locking slide mount. This makes installation and removal very easy.



1. FREQUENCY/CLOCK DISPLAY
2. TAPE EJECTION CONTROL
3. CASSETTE DOOR
4. MEMORY PROGRAM CONTROL
5. AM/FM SELECTOR
6. TAPE ADVANCE (<<)/PROGRAM CONTROL
   TAPE ADVANCE (>>)/PROGRAM CONTROL
7. FREQUENCY/TIME RECALL CONTROL
8. ON/OFF VOLUME AND PULL BALANCE CONTROL
9. FADER CONTROL
10. TREBLE CONTROL
11. BASS CONTROL
12. MANUAL TUNING CONTROL
13. 12 FM/6 AM PRESET MEMORY BUTTON
14. STATION SEEK CONTROL
15. CD INPUT FOR COMPACT DISC PLAYER
16. MO/ST BUTTON
17. MEMORY SCAN
18. METAL TAPE SELECTOR
19. AUTO STORE SYSTEM

9435

Figure 1. RAC R-655 AM/FM Stereo Radio & Cassette Player

C. In conjunction with the audio/video entertainment system, there is a specially modified VHS video cassette or disc player located in the parcel rack. Optional TV tuner module allows the operator convenient control over channel changes and VHF/UHF switching function. An optional Karioke system is also available.

D. A digital Audio processor that incorporates an enhanced reliability and complete centralized system control. The System 2000's Microprocessor allows the operator to control up to three audio selections, allowing custom tailoring of each channel's sound quality. There are three microphone inputs for the Public Address System, which is switchable between internal and external speakers. The unit contains a separate Video Section for controlling the VCP and allows the driver to control his own separate audio selections.

OPERATION

RADIO/CASSETTE PLAYER (R-655)

Power/Volume/Pull Balance Control (8)

To switch the unit on, turn the volume control knob clockwise. Adjust volume knob to desired level.

Pull and turn this knob to balance the sound between the right and left speakers.

Fader Control (9)

Turn this knob to regulate the distribution of sound level between the front and rear speakers. (In a two speaker system installation, this control becomes in-operative.)

Treble Control (10)

Adjust the knob to desired treble response.

Bass Control (11)

Adjust the knob to the desired bas response.

Band Selector (5)

Pushing this button selects either AM or FM (FM1/FM2) radio bands, and display will indicate selection.

Tape Cassette Door (3)

Insert a cassette tape through the cassette loading slot. The cassette will engage and automatically switch the unit from radio to tape player. As soon as a cassette is engaged into the mechanism, one of the tape direction indicators will light.

Auto/Manual Reverse Program (6)

When the tape comes to the end of one side in any mode, it will automatically reverse and play the other side. To reverse the tape at any time, push both fast forward and rewind buttons together.

Fast Forward/Rewind (6)

For fast winding the cassette tape in either direction, depress either forward or rewind buttons. When the tape is fully wound, the button which has been depressed is automatically released and playing resumes in the new direction. To stop fast winding mode at any time, lightly push the other fast wind button. The tape will resume playing.

Eject Button (2)

To remove the cassette, push the eject button. The cassette will be ejected halfway for easy removal.

Metal Tape Selector Button (18)

When playing a metal or CrO_2 type cassette, push this button to activate the proper sound equalizer. When the metal tape equalizer is activated, the letters MTL will appear on the display.

Manual Tuning/Clock Adjust (12)

Radio station and time set may be manually tuned in by pushing the “UP” or “Down” buttons. When released, the station frequency will remain locked.

Auto Tuning “Seek” Control (14)

Push the **SEEK** button and the radio will automatically tune in the next higher available band’s station.

Auto “Memory Scan” Control (17)

Push the scan button and the radio will automatically tune in the next available preset station in that memory address for approximately seven seconds, and then proceed to the next station continuously. Press button again to stop scanning function.

Recall Frequency/Time Control (7)

This display will generally indicate the radio frequency while radio is in operation. To change the display to time, push the RCL button

FM Stereo/Mono Selector Button (11)

To receive the FM stereo broadcasting, press this button. The stereo indicator will light up. If FM noise or fading due to a weak signal is presence, switching this one off will improve the reception.

Memory/Time Program Control (4)

Pressing the **MEMO** button, memory function is used with the preset buttons and manual tuning control to input radio station frequencies. When setting the time, press this control, then use the clock adjust buttons. See (“Preset Radio Frequencies” & “Digital Clock Set”) later in these instructions.

Preset/Recall Memory Buttons (13)

Recall memory buttons (6) provides a quick one button station change which have been programmed on FM1, FM2, FM3, and AM. Select the correct band before pressing these recall buttons

FM Stereo/Mono Selector Button (16)

To receive the FM stereo broadcasting, press this button. The stereo indicator will light up. If FM noise or fading due to a weak signal is presence, switching this off may improve the reception.

Auto Storage System (19)

Pressing the **MEMO** and **SEEK** buttons simultaneously to memorize up to 12 FM and 6 AM stations automatically. The system will scan the frequency band and the strongest six stations are automatically programmed on the six preset buttons within each address group. This is done in the order of their signal strength.

Compact Disc Player Input (15)

Any portable CD player can be plugged into the input jack.

Digital Display

The display shows hour and minute for clock function, and frequencies 87.5-107.9 MHz (FM) and 530-1620 (AM) for radio function. Additionally, cassette tape direction is shown during play.

DIGITAL CLOCK SET

Turn power **VOLUME/ON-OFF** control Knob “On”. Radio frequency will appear on display. Press the **RCL** button to display time. Push the **MEMO** button momentarily. This will make the time on display blink for about five seconds. Press DOWN symboled button to adjust hours, and UP button for minutes.

PRESETTING RADIO FREQUENCIES

This unit has one AM and two FM address groups, which can accommodate six separate AM/FM stations each. Turn the **VOLUME/ON-OFF** control knob on. The lowest radio frequency will appear on display. Push **BAND** button momentarily and **F1** will appear on display. Select the desired FM station by using the manual Timing/Clock Adjust Control’s UP/DOWN buttons. Push **MEMO** button and **CH** will display and blink. Press one of the six numbered preset buttons within five seconds to store the station in memory. Repeat the procedure to store the other five selections.

Press the **BAND** selector button again and **F2** will appear on the display. Repeat the above procedure until all six selections are made. Press the **BAND** selector once again and the **A1** will now appear. Repeat the procedure again until all six selections are made.

DIGITAL AUDIO PROCESSOR

Refer to the coach “Operators Manual” for detailed operational instructions on the microprocessor.

MAINTENANCE

ADJUSTING THE LOW LEVEL INPUTS

The input sensitivity is adjustable from 100mV to 1V to match the output of the radio or tape deck. Set the volume control on the radio, then, adjust the input control on the amplifier for an average listening level. This gives the best balance between radio output and system signal-to-noise ratio (Figure 2 3).

CAUTION

The Low Level Input Adjustment for this amplifier has been preset to system specifications.

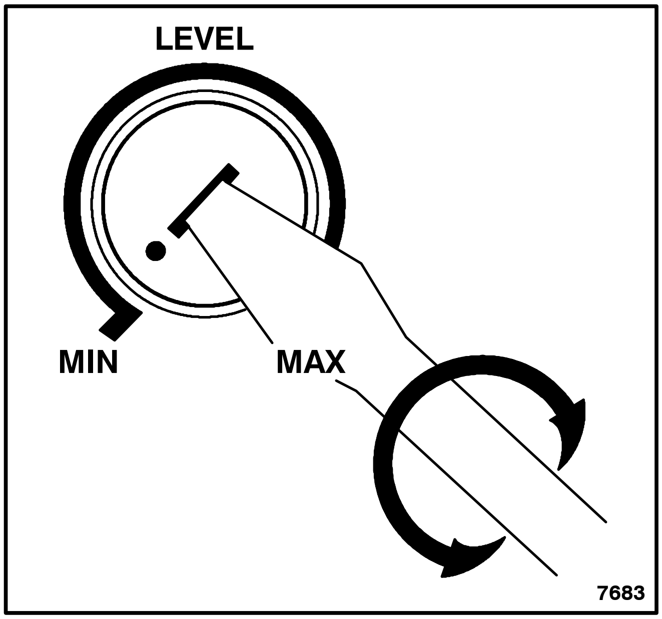

LEVEL
MIN
MAX
7683

Figure 2. Amplifier Low Level Input Adjustment

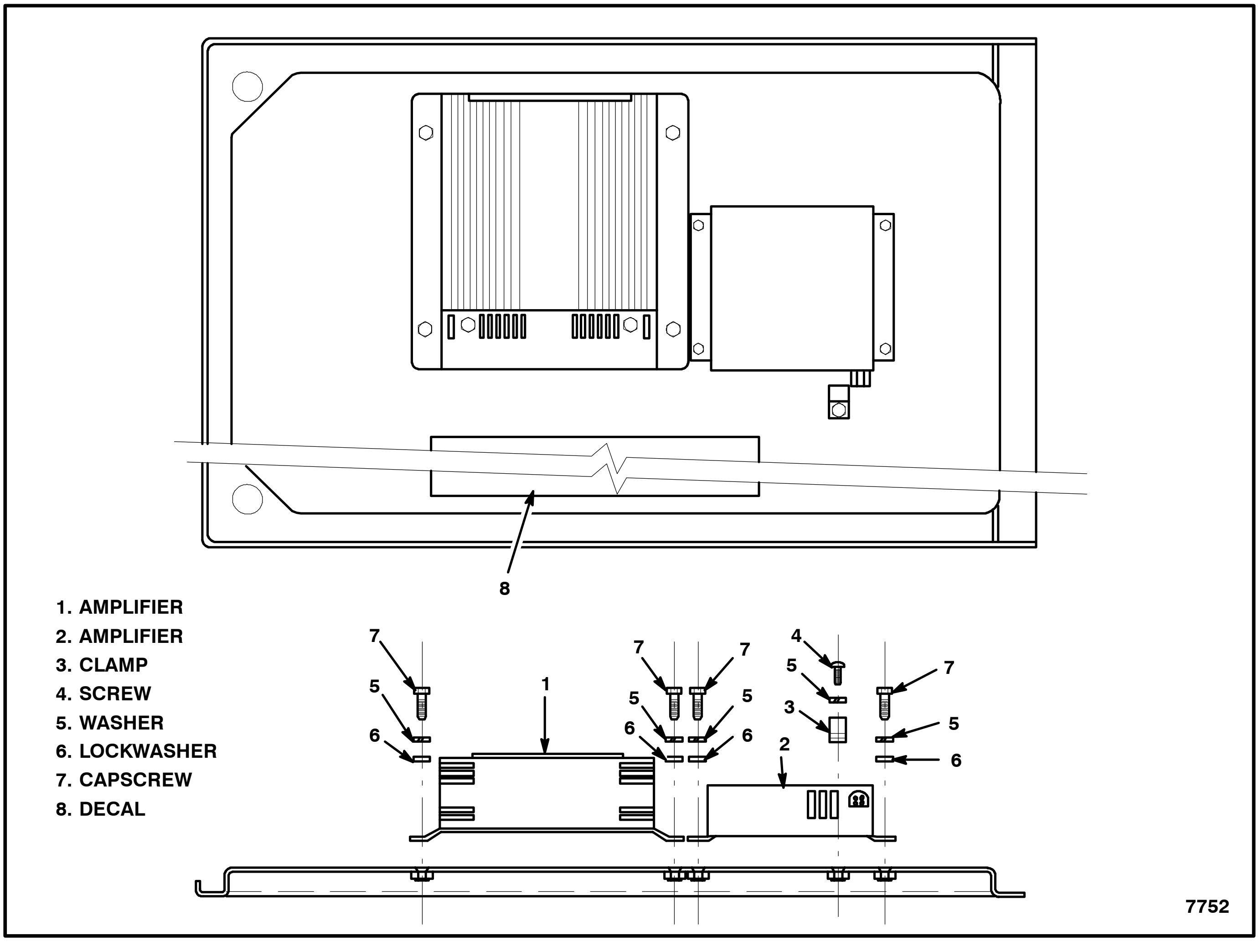

1. AMPLIFIER
2. AMPLIFIER
3. CLAMP
4. SCREW
5. WASHER
6. LOCKWASHER
7. CAPSCREW
8. DECAL
1
2
3
4
5
6
7
8
7752

Figure 3. Amplifier Mounted on J-box Door

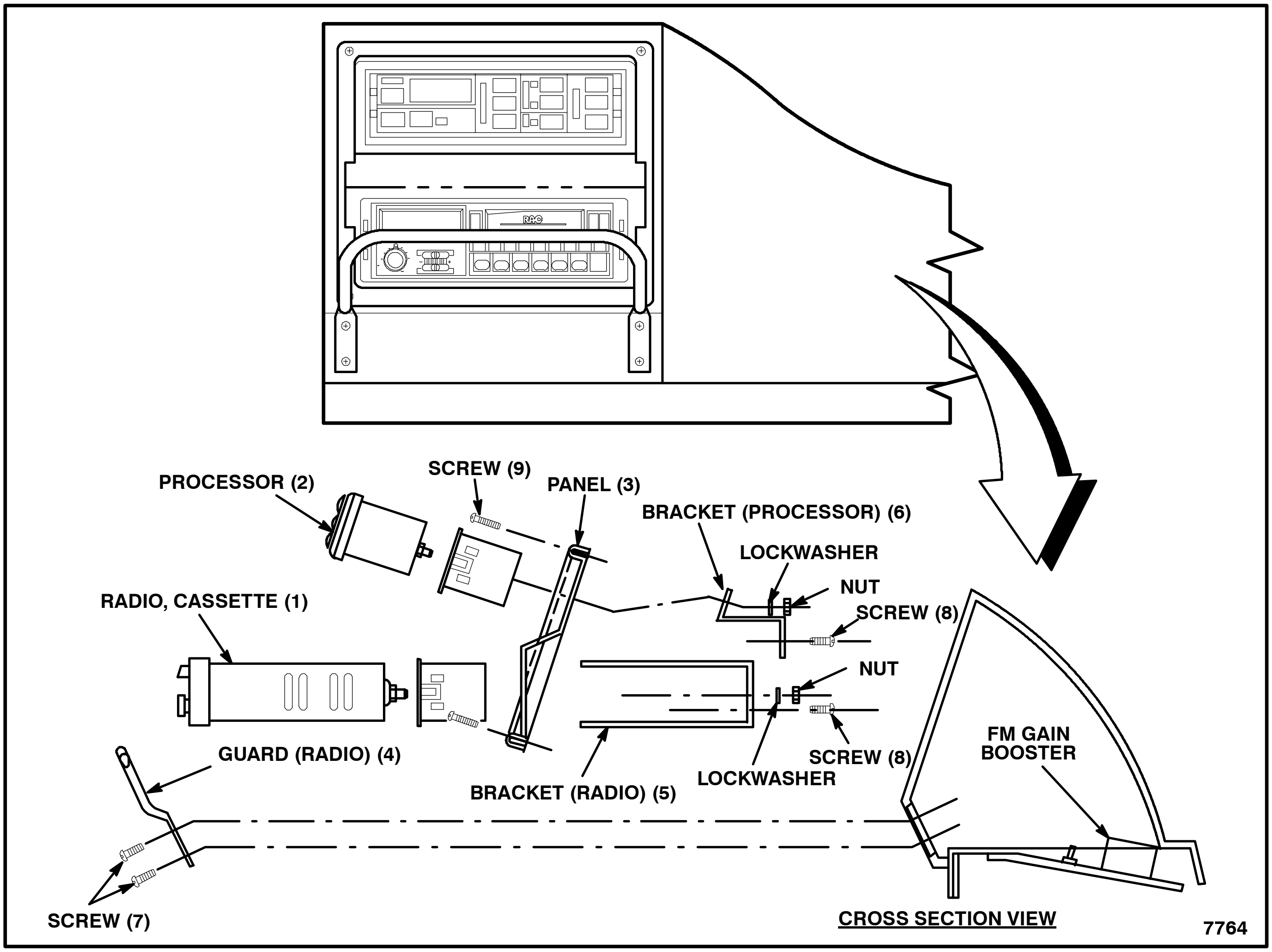

PROCESSOR (2)
SCREW (9)
PANEL (3)
BRACKET (PROCESSOR) (6)
LOCKWASHER
NUT
SCREW (8)
RADIO, CASSETTE (1)
NUT
FM GAIN BOOSTER
GUARD (RADIO) (4)
SCREW (8)
LOCKWASHER
BRACKET (RADIO) (5)
SCREW (7)
CROSS SECTION VIEW
7764

Figure 4. Radio/Cassette and Audio/Video Processor Mounting

RADIO/PROCESSOR REMOVAL

1. Place the battery disconnect switches in the “OFF” position.
2. Remove the guard mounted to the dash below the radio (Figure 4).
3. Remove the panel screws (9) and pull the panel with radio/processor assembly from the dash.
4. Disconnect the power and speaker wiring.

NOTE: See “Cable Run Sheet” (7L-13-666) for RAC 2000 in the schematics sub-section 7J.

5. Disconnect the bracket (6) from the radio.
6. Disconnect bracket (6) from the processor.
7. Press in on the locking tabs (each side) and remove the processor from the panel.
8. Press in on the locking tabs and remove the radio from the panel.
9. If the FM gain booster mounted behind the radio is to be removed, disconnect harness and unfasten screws to remove (Figure 4).

RADIO/PROCESSOR INSTALLATION

1. Slide sleeve onto radio (1).
2. Place mounting bracket (5) and fasten with nut, lockwasher and screw (8).
3. Slide radio and bracket assembly into lower opening of panel (3) until sleeve snaps into place.
4. Slide mounting sleeve onto processor.
5. Insert processor into upper opening of panel (3) until sleeve snaps into place.
6. Place bracket (6) on stud at back of processor fasten with nut and lockwasher.
7. Align bracket (6) with radio mounting bracket hole and fasten with screw (8).
8. Connect power and speaker wires.

9. Mount and connect wiring to FM gain booster before installing the panel with radio/processor.

10. Position panel with radio and processor into right-hand dash and fasten with screws (9).

11. Install guard (4) with screws (7) on dash below the radio.

12. Turn battery disconnect switches “ON”.

PA CONTROL REMOVAL (MAIN)

1. Place the battery disconnect switches in the “OFF” position.

2. Remove the panel screws (9) and pull the panel/radio assembly from the dash (Figure 5).

3. Remove the mounting plate (2) screws and plate.

4. Remove the PA Control Unit.

5. Disconnect the power and speaker wiring.

PA CONTROL INSTALLATION (MAIN)

1. Insert the Control Unit (1) into the panel opening.

2. Place plate (2) in position and fasten with screws.

3. Connect PA Control Unit wiring.

4. Position panel with Control Unit on dash and fasten with screws (4).

5. Turn battery disconnect switches “ON”.

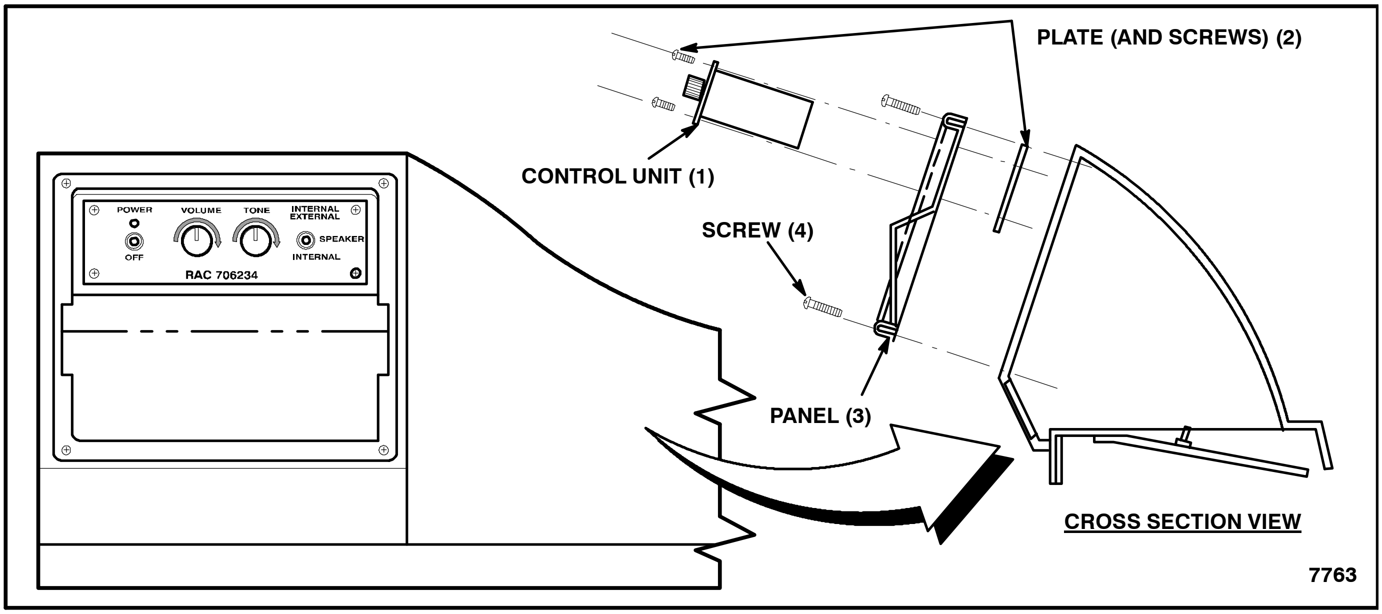


Figure 5. RAC 200254 PA Control Unit

VCP/VCR REMOVAL

1. Place the battery disconnect switches in the “OFF” position.

2. Remove service module mounting screws and gently lower to end of harness.

NOTE: Do not let service modules drop.

3. Remove VCP/VCR mounting locknuts (3) from rubber mounts (2) (Figure 6).

4. Disconnect wiring.

5. Remove VCP/VCR unit (1) from parcel rack.

6. Replace service module to prevent damage to wiring.

VCP/VCR INSTALLATION

1. Remove service module mounting screws and gently lower to end of harness.

2. Insert VCP/VCR into parcel rack and align rubber mount studs to mounting holes. Insert mount studs through mounting holes.

3. Install locknuts (3) on mount studs.

4. Connect wiring.

5. Replace service module.

6. Turn battery disconnect switches “ON”.

MICROPHONE REMOVAL (BOOM TYPE)

1. Place the battery disconnect switches in the “OFF” position.

2. Remove mounting screws (4) at mounting flange (Figure 7).

3. Disconnect wiring.

MICROPHONE INSTALLATION

1. Connect Wiring.

2. Align mounting flange with holes and install screws (4).

3. Remove spacer block (1) mounting screws (2).

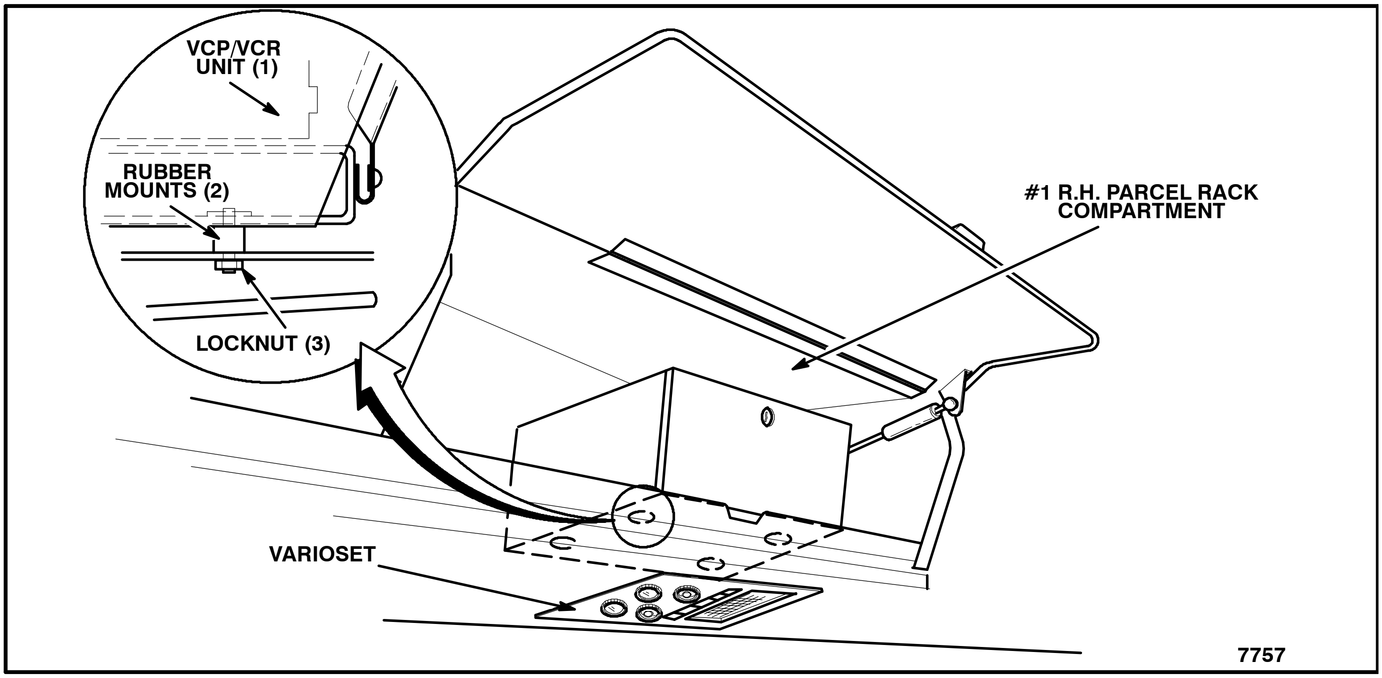

VCP/VCR UNIT (1)
RUBBER MOUNTS (2)
LOCKNUT (3)
#1 R.H. PARCEL RACK COMPARTMENT
VARIOSET
7757

Figure 6. VCP/VCR Unit Located in #1 RH Parcel Rack

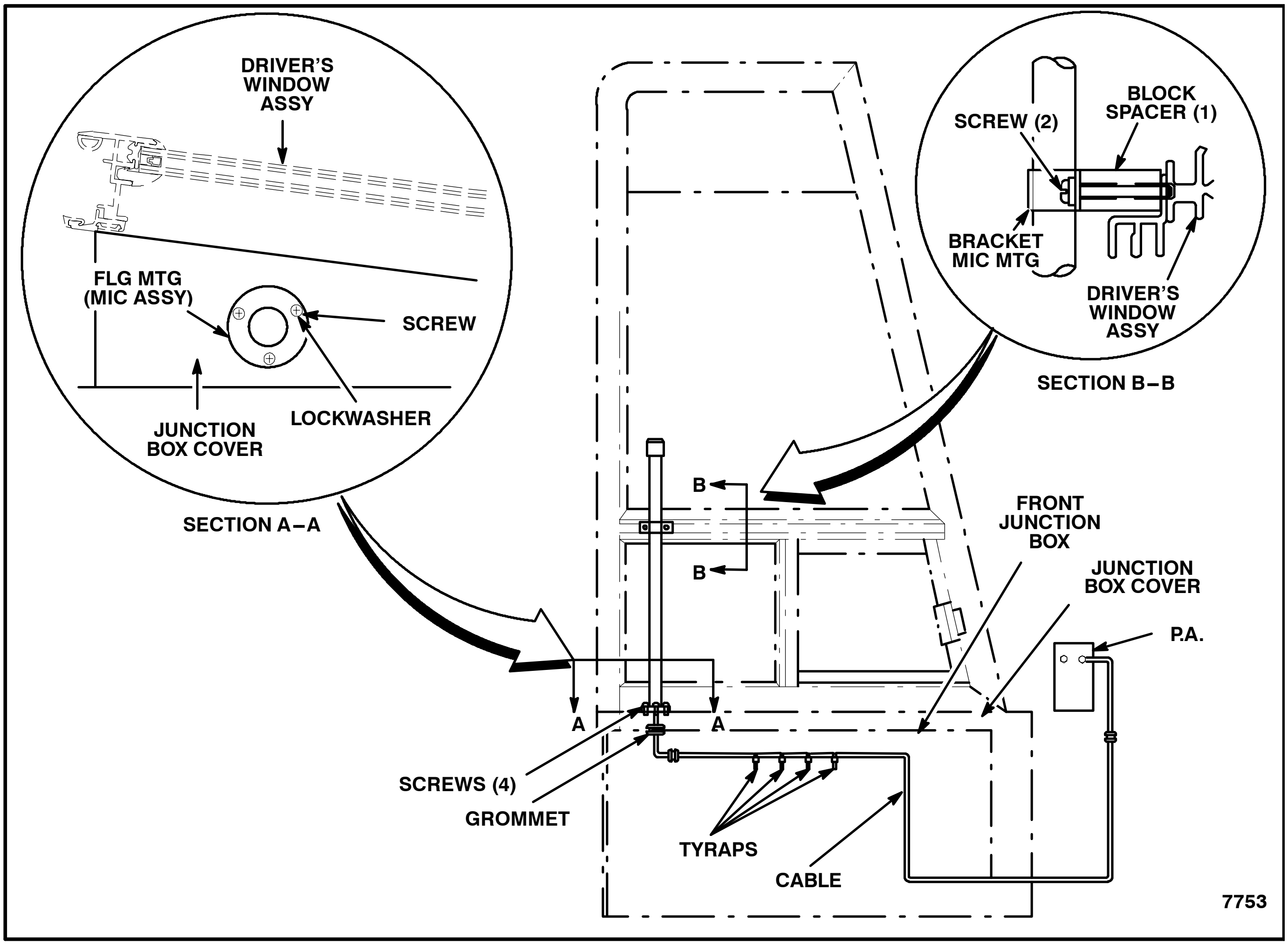
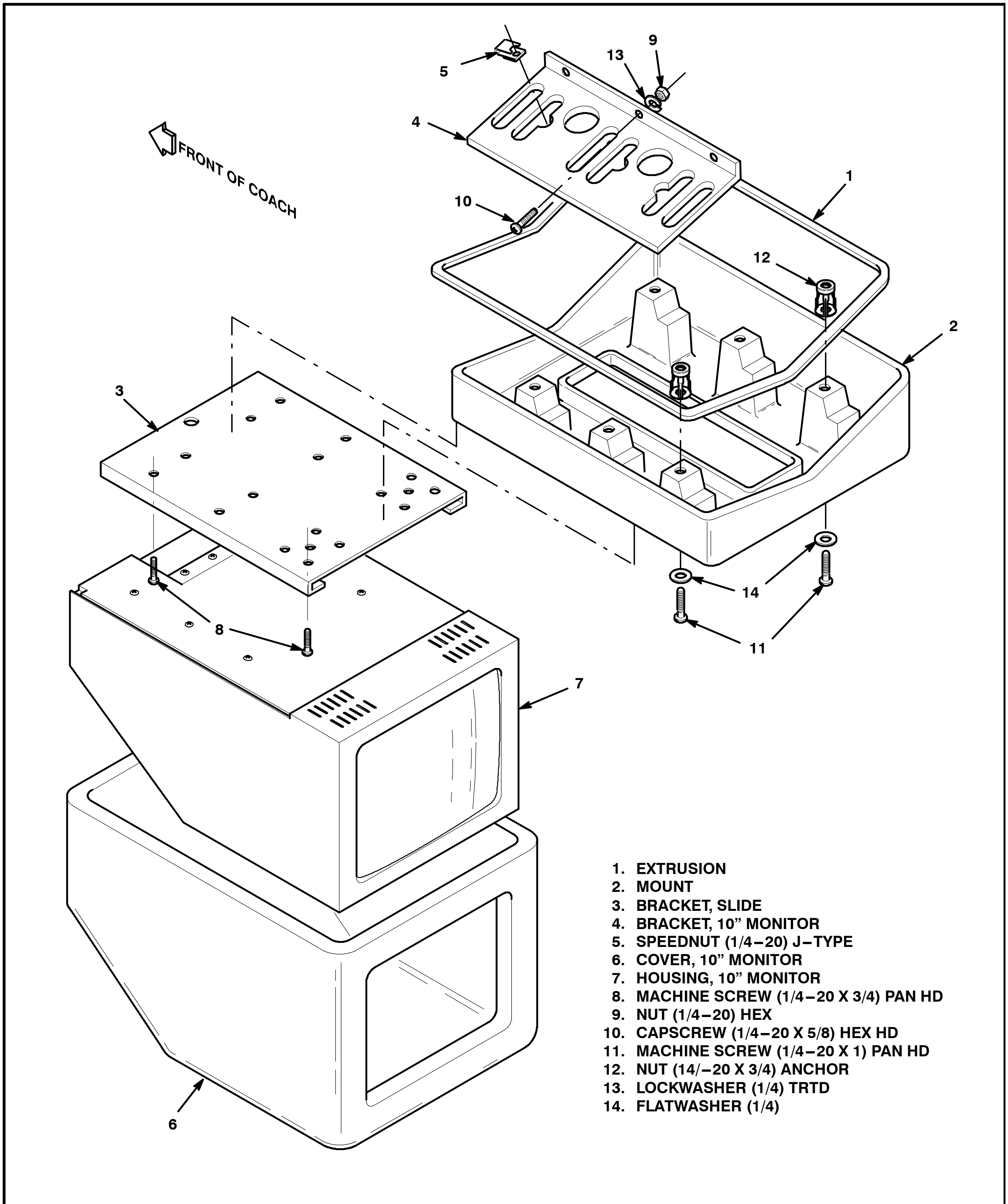

DRIVER'S WINDOW ASSY
FLG MTG (MIC ASSY)
SCREW
JUNCTION BOX COVER
LOCKWASHER
SECTION A–A
SCREW (2)
BLOCK SPACER (1)
BRACKET MIC MTG
DRIVER'S WINDOW ASSY
SECTION B–B
B
B
FRONT JUNCTION BOX
JUNCTION BOX COVER
P.A.
A
A
SCREWS (4)
GROMMET
TYRAPS
CABLE
7753

Figure 7. Microphone (Boom-Type)

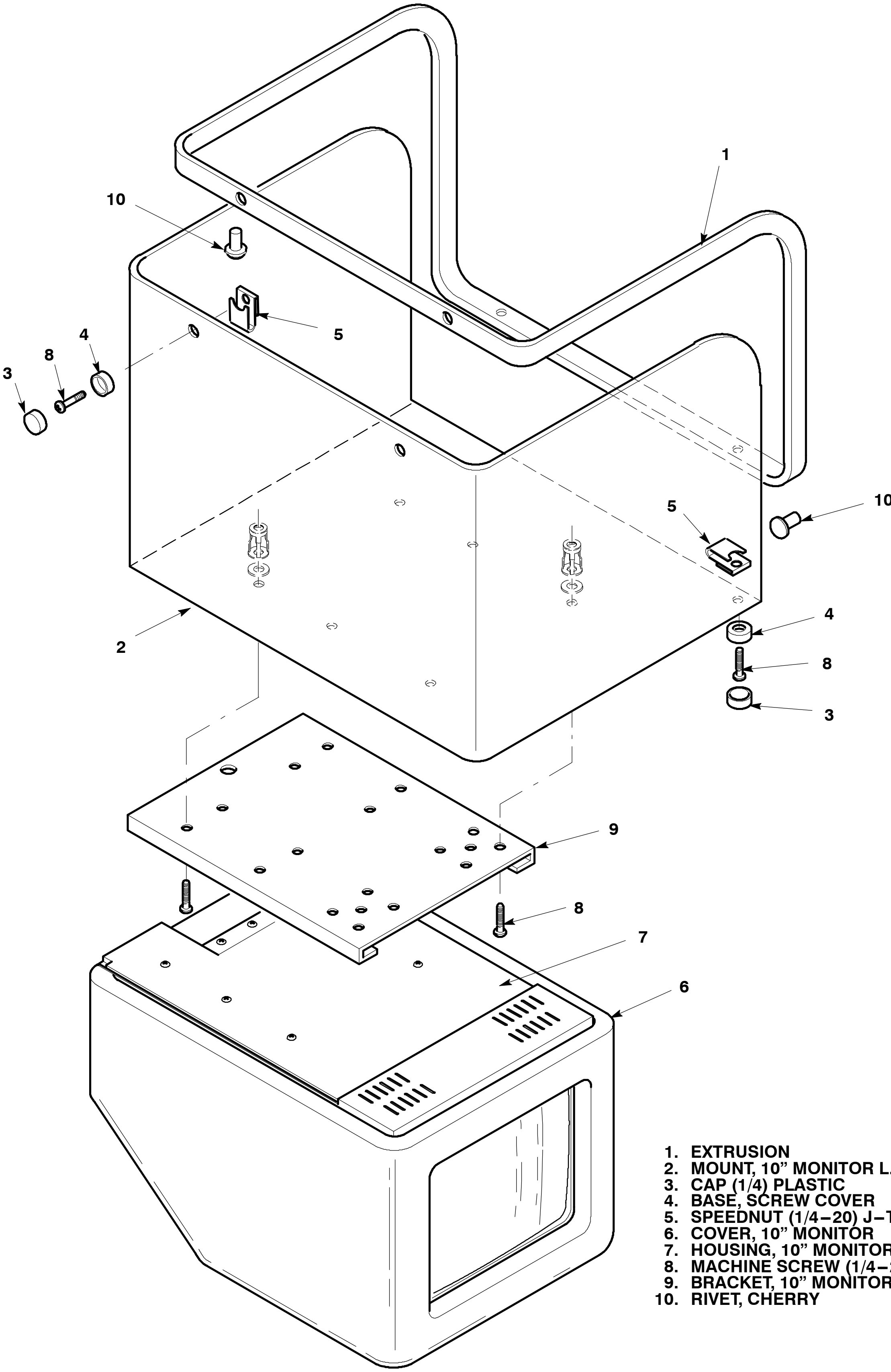


1. EXTRUSION
2. MOUNT
3. BRACKET, SLIDE
4. BRACKET, 10” MONITOR
5. SPEEDNUT (1/4−20) J−TYPE
6. COVER, 10” MONITOR
7. HOUSING, 10” MONITOR
8. MACHINE SCREW (1/4−20 X 3/4) PAN HD
9. NUT (1/4−20) HEX
10. CAPSCREW (1/4−20 X 5/8) HEX HD
11. MACHINE SCREW (1/4−20 X 1) PAN HD
12. NUT (14/−20 X 3/4) ANCHOR
13. LOCKWASHER (1/4) TRTD
14. FLATWASHER (1/4)

R.H. MOUNT SHOWN

7681

Figure 8. Video Monitors Parcel Rack Mounted



1. EXTRUSION
2. MOUNT, 10” MONITOR L.H.
3. CAP (1/4) PLASTIC
4. BASE, SCREW COVER
5. SPEEDNUT (1/4−20) J−TYPE
6. COVER, 10” MONITOR
7. HOUSING, 10” MONITOR
8. MACHINE SCREW (1/4−20 X 1) PAN HD
9. BRACKET, 10” MONITOR
10. RIVET, CHERRY

Figure 9. Video Monitor Transom Panel Mounted

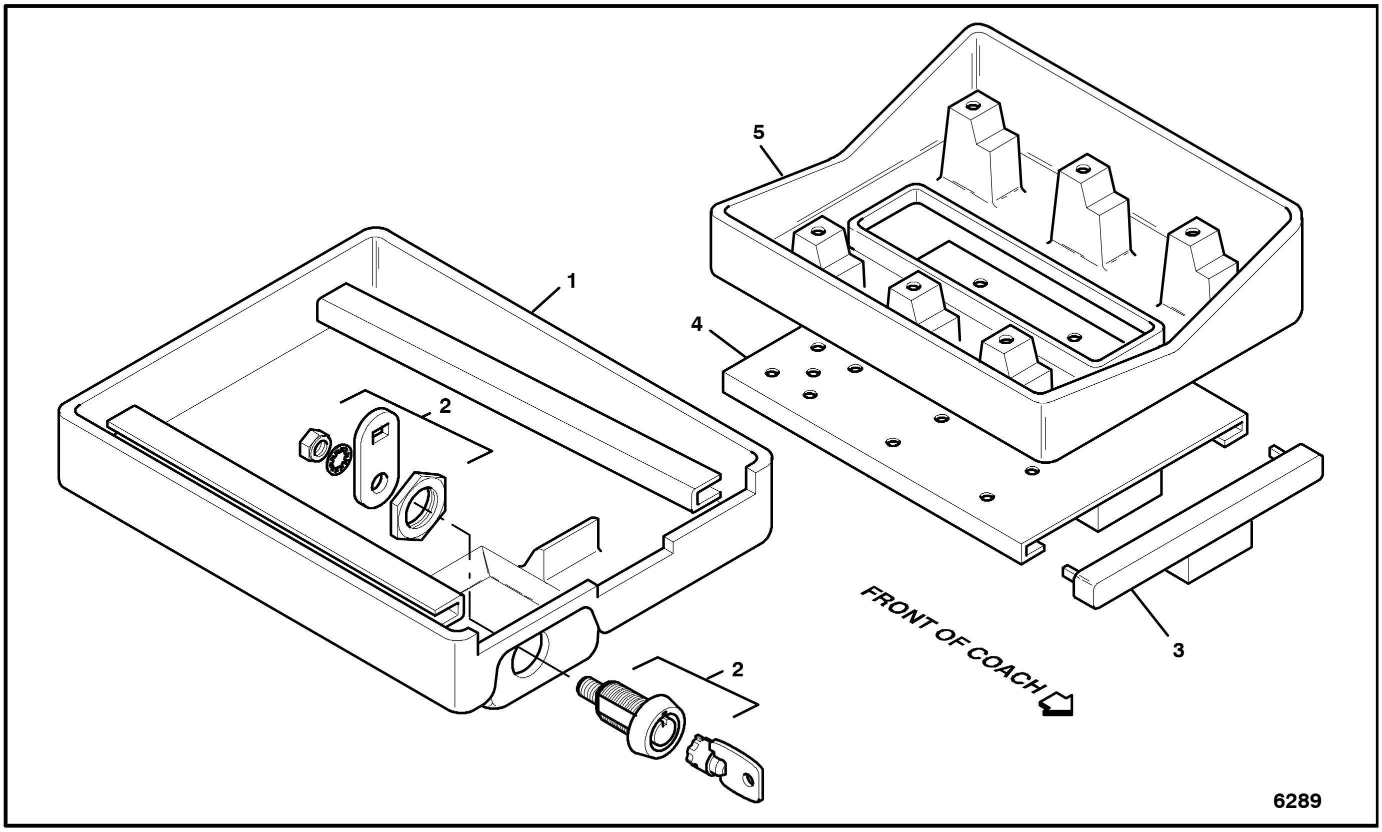


Figure 10. Monitor Mounting Cover

4. Insert spacer block and install mounting screws.
5. Turn battery disconnect switches “ON”.

MONITOR REMOVAL

The six, ten-inch color monitors (Figures 8, 9, & 10), are slide mounted and retained by keyed locks. An LED light on the back indicates if the monitor is “ON”. The “RED” button is the monitor on/off switch and the pin style button is the circuit breaker reset button.

1. Place the battery disconnect switches in the “OFF” position.
2. Unlock the monitor slide and pull toward front of monitor.
3. After removal, cover mount location with monitor cover assembly and lock (Figure 10).

INSTALLATION

1. Remove cover over mounting bracket if needed.
2. Align monitor mount with slide and slide monitor or mount cover into place.
3. Lock monitor or cover to prevent removal.

NOTE: Be sure connections are not bent or damaged. If monitor is not being replaced, immediately install the mounting cover (Figure 10).

DRIVER’S SPEAKERS

The driver’s speakers are mounted on the front side of the driver’s modesty panel, one on each side (Figure 11). This arrangement provides the driver with clear stereo sound. Controls for the driver’s audio allows selection between the radio or the auxiliary audio (independent of the passenger’s speakers) or of muting the speakers.

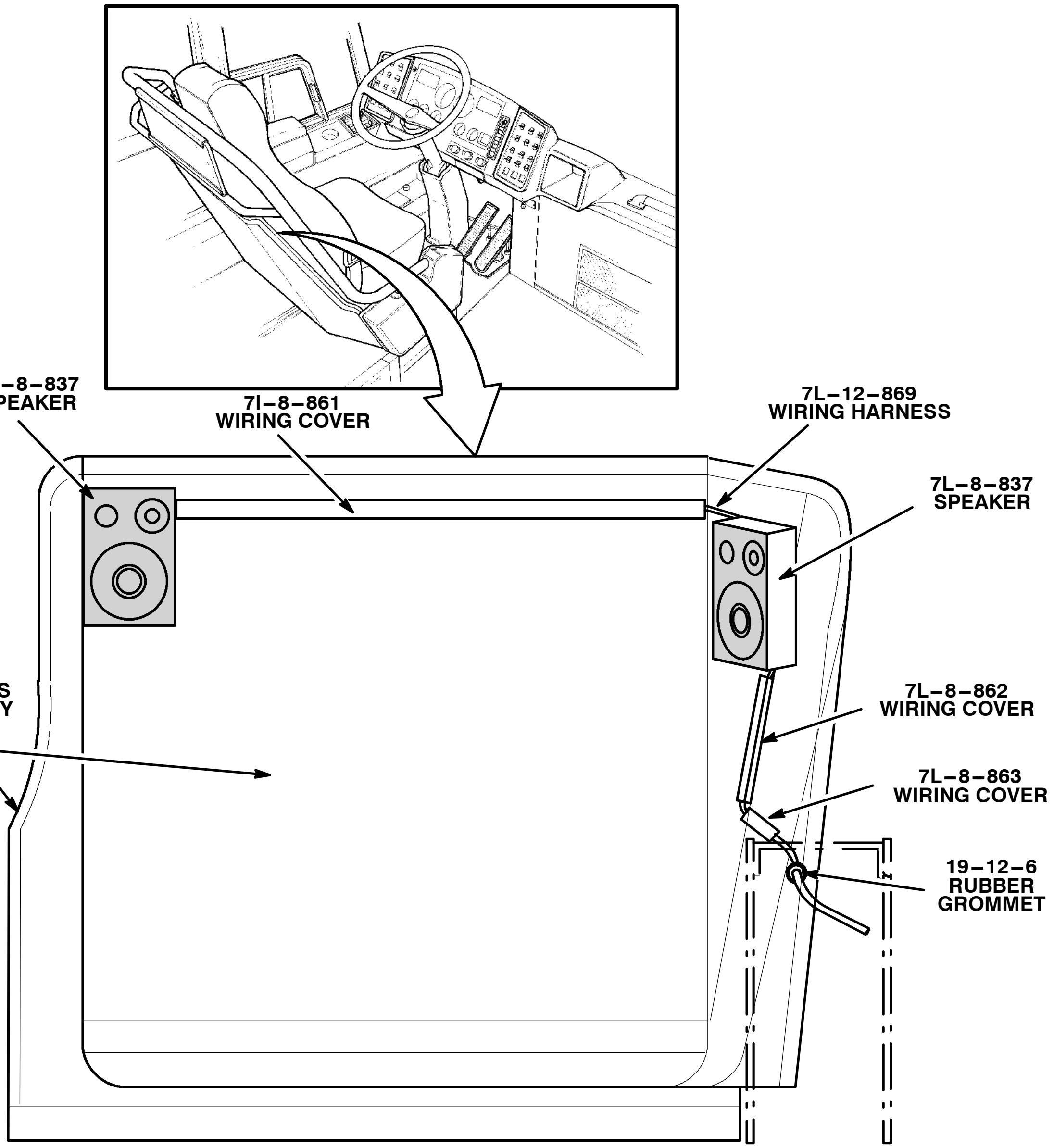

7L–8–837
SPEAKER
7l–8–861
WIRING COVER
7L–12–869
WIRING HARNESS
7L–8–837
SPEAKER
DRIVER'S
MODESTY
PANEL
7L–8–862
WIRING COVER
7L–8–863
WIRING COVER
19–12–6
RUBBER
GROMMET
7426

Figure 11. Driver's Speakers

SPECIFICATIONS

FEATURES: RAC R-655 AM/FM STEREO RADIO & CASSETTE PLAYER

- AM/FM stereo radio.
- Auto reverse cassette player.
- Digital clock
- Digital LCD display.
- Programmable 18 station (three address) storage.
- Clock and radio memory function.
- One-button search/scan station tuning.
- Manual digital station tuning.
- 25 watt output power per channel.
- Metal tape capability.
- Bass and treble controls.
- Fader control.
- Balance control.
- Stereo/mono selector.
- FM/AM station selector.
- Fast forward/rewind controls.

AM/FM STEREO RADIO/CASSETTE PLAYER

Part Number (w/o Battery Backup) (Effective with Unit 49048)	7L-8-1860
Player system	4-track, 2-channel stereo
Tape speed	1-7/8"/sec. (4.75 cm/sec.)
Wow & flutter	0.25% (WRMS)
Frequency response: normal tape	60-15000Hz
S/N ratio (normal)	55 dB
Stereo separation	40 dB
FM Tuning Range	87.5 to 107.9 MHz
Sensitivity	4 V/75 ohm
Selectivity (at ± 400KHz)	40 dB
Frequency response	40 - 15000 Hz
Stereo separation	30 dB
AM Tuning Range	530 - 1620 KHz
Sensitivity	40 V
Selectivity	30 dB

PUBLIC ADDRESS (PREAMP VOLUME/TONE CONTROL MODULE)

Part Number (Main Installation)	7L-8-660
Part Number (Back-Up Installations)	7L-8-657
Dimensions	189x58x18 mm
Weight	1.8 kgs

SPECIFICATIONS (Contd.)

POWER AMPLIFIER

Part Number (Main Installation)	7L-8-642
Part Number (Back-Up Installations)	7L-8-655
Power Supply	24 VDC negative ground
Current	8 amps max.
Max. power output (Main Installation)	70 watts RMS at 4 ohm @ 0.5 T.H.D.(90 watts/channel Max)
Frequency response	10 - 30000 Hz
Signal to Noise ratio	86 dB
12V Power supply output	Maximum 2 amps negative ground for auxiliary use
Weight	2.66 Kg
Dimensions	254x73x260 mm

VIDEO SYSTEM MONITOR (10")

Part Number (All Locations)	7L-15-2244

VIDEO SYSTEM PLAYER

Part Number	7L-8-671

VIDEO SYSTEM RECORDER

Part Number (All Locations)	7L-8-684

SECTION 7I

INTERIOR AND EXTERIOR LIGHTING

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	7I-1
Components	7I-1
Operation	7I-3
Maintenance	7I-5
Specifications	7I-8

GENERAL DESCRIPTION

The 102D series coaches utilize a variety of interior passenger (service module, seat mounted aisle lamps, lavatory lights and parcel rack overhead aisle and window lamps) and driver (dash and overhead) lighting.

The exterior of the coach is provided with a normal complement of federally mandated front, side and rear coach lighting consisting of Hi/Lo headlamps turn lamps, stop/taillamps, turn lamps (including strategically located side turn signals and high mounted stop lamps), back-up lamps, reflectors and specialized clearance and identification lamps.

Switches for operation of internal and external lights are located in the driver's area and will be addressed in this section.

COMPONENTS

AISLE LAMPS

Aisle lights attached to the underside of designated seats illuminate and clearly mark aisle areas. These lamps are powered via a harness which connects to the sidewall heat duct connectors.

OVERHEAD LIGHTING

Overhead window and aisle florescent lamps are mounted in the parcel rack assemblies. Additional reading lamps are provided in the service module assemblies.

HEADLAMPS

Each headlight assembly (Figure 1) consists of two rectangular sealed-beam units. Outer lamps are two filament units having high and low beams. Inner lamps have one filament and operate with high beam of outer unit. For identification purposes, outer units are molded with "2A" and inner units are molded with "1A" in top of lens.

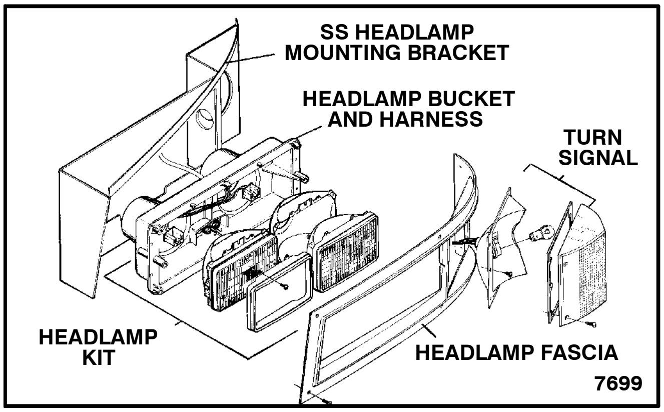


Figure 1. Headlamp Assembly

TURN SIGNALS

Front

The front turn signal is a part of the front headlamp cluster. The turn signal lens is located on each front corner and shares a common bezel with the headlights. This turn signal is visible from both front and sides.

Side

Three side turn signal lights are provided on each side of coach. These lights are located behind the front wheelhousing, in the middle of the rear wheelhousing and in the #2 baggage doors.

Rear

The rear turn signal is located in the center cluster adjacent to the reflector and stop/tail lamp.

TAILLAMP ASSEMBLY

Housing Mounted

The taillights are installed in cast aluminum housings which are mounted to the rear corners of the coach (see Figure 2). Both the left-hand and right-hand clusters are in access doors; the right-hand taillight cluster is mounted in the A/C compressor access door, the left-hand door gives access to the engine air filter, an additional stoplamp is installed in the center of the blower compartment door.

> **NOTE:** Effective with Unit #45959 the housing mounted taillight assemblies were replaced with different type panel mounted assemblies.

Panel Mounted

The panel mounted taillight arrangements are installed in the upper rear cap, the LH/RH intermediate corner panels and the LH/RH rear access doors (Figure 3). Lower lamp clusters in intermediate panel contain a wraparound corner tail/stop lamp (red), a reflector (red), turn lamp (orange) and stop lamp (red). The back-up lamps (white) are mounted in the access doors, with an additional high-mounted wraparound corner stop lamps (red) are installed in the upper cap.

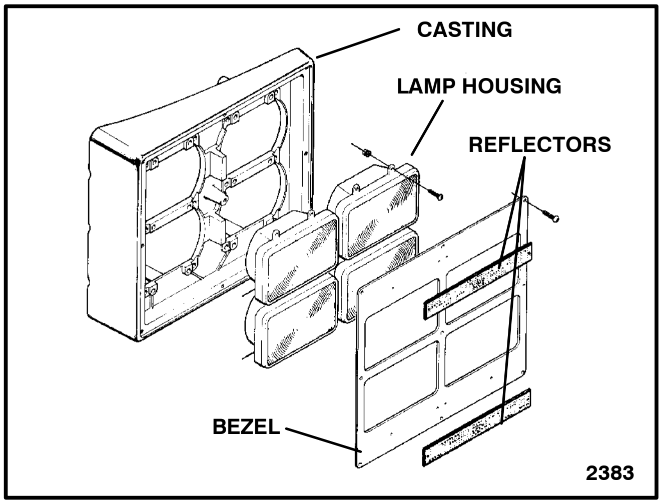


Figure 2. Taillight Assembly

REFLECTORS

Reflectors are also used to provide additional warning. The taillight housings have strips of reflective tape, while the center cluster has a plastic lens. An additional strip of reflective tape is applied to the inner edge of the taillight housing to provide reflectors facing the roadway when the access door is open.

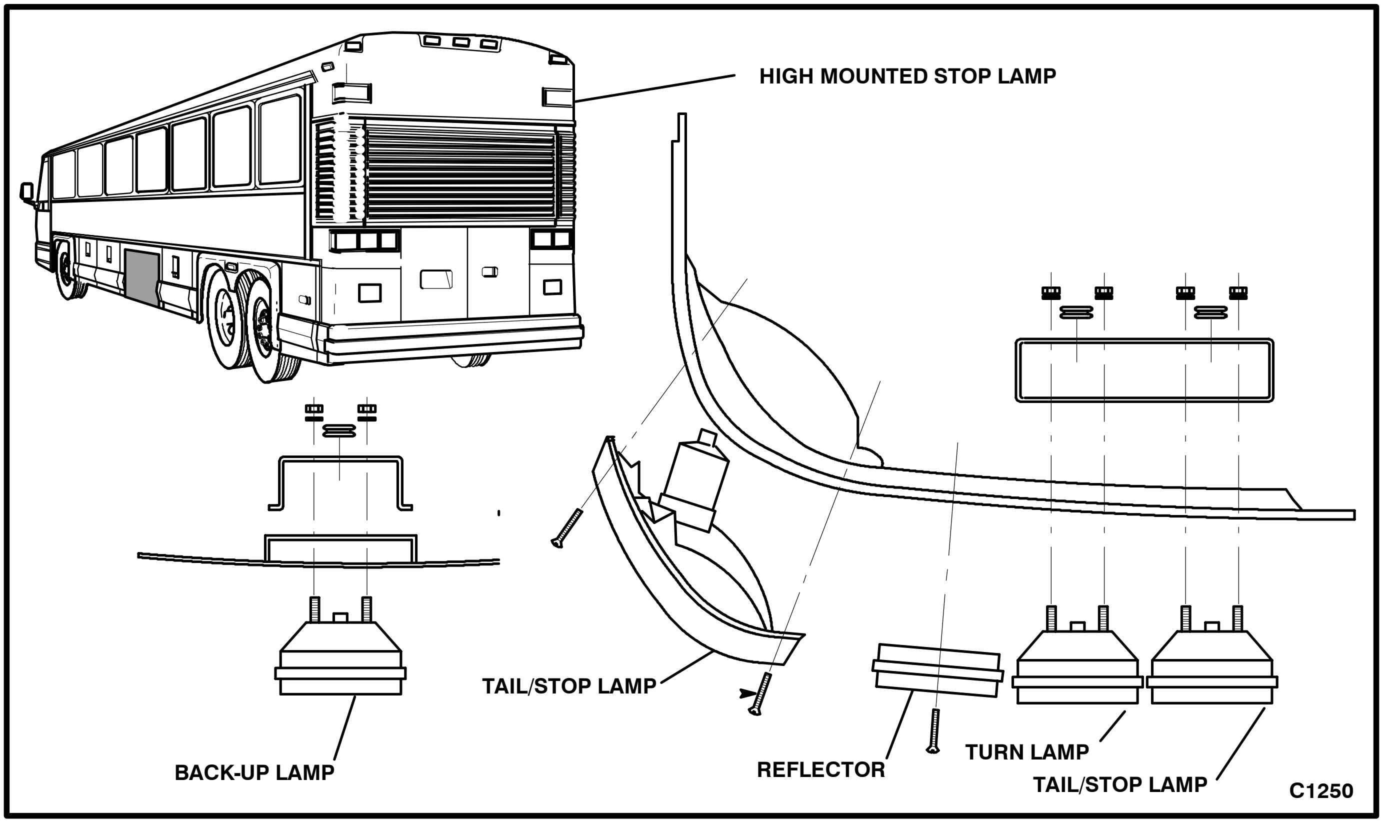
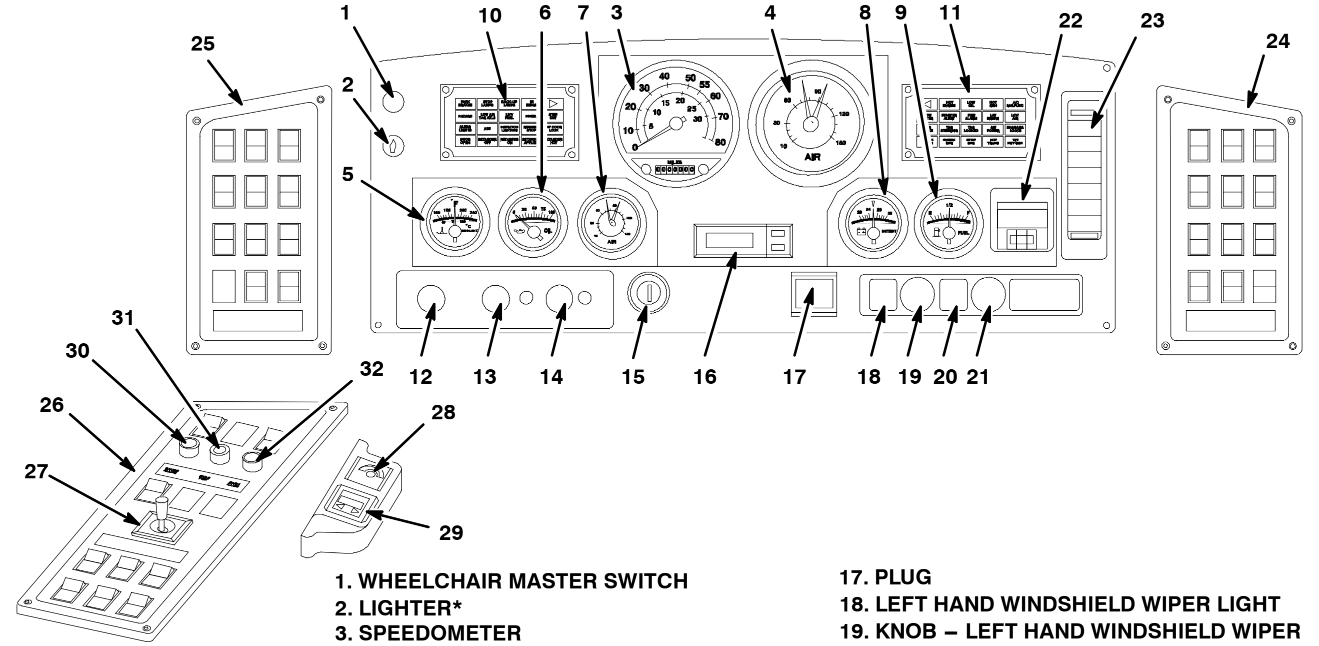


Figure 3. Panel Mounted Taillamp Arrangement



1. WHEELCHAIR MASTER SWITCH
2. LIGHTER*
3. SPEEDOMETER
4. LARGE AIR GAUGE
5. WATER TEMPERATURE GAUGE
6. OIL PRESSURE GAUGE
7. PLUG (TRANS TEMP*- SMALL AIR GAUGE**)
8. VOLTOMETER
9. FUEL GAUGE
10. L.H. TELL–TALE CLUSTER
11. R.H. TELL–TALE CLUSTER
12. MICROPHONE JACK
13. KNOB–TONE CONTROL
14. KNOB–VOLUME CONTROL
15. IGNITION SWITCH
16. DIGITAL CLOCK
17. PLUG
18. LEFT HAND WINDSHIELD WIPER LIGHT
19. KNOB – LEFT HAND WINDSHIELD WIPER
20. RIGHT HAND WINDSHIELD WIPER LIGHT
21. KNOB – RIGHT HAND WINDSHIELD WIPER
22. MAIN TEMPERATURE CONTROL (DIGITAL)
23. DRIVER FRESH AIR VENT
24. RIGHT HAND UPPER SWITCH PANEL
25. LEFT HAND UPPER SWITCH PANEL
26. LOWER LEFT HAND SWITCH PANEL
27. MIRROR REMOTE CONTROL
28. DRIVER TEMPERATURE CONTROL (DIGITAL)
29. WEBASTO TIMER/CONTROL (DIGITAL)
30. DASH ILLUMINATION
31. BULB TEST SWITCH
32. GAUGE ILLUMINATION

* Optional

** Used when Tachometer option is called

C1249

Figure 4. Instrument Panel With Webasto Panel

CLEARANCE & IDENTIFICATION LIGHTS

The coach clearance (outboard) and identification (inboard) lamps mount on the exterior upper front and rear caps. Additional side clearance lamps mount along the upper sidewall of the coach.

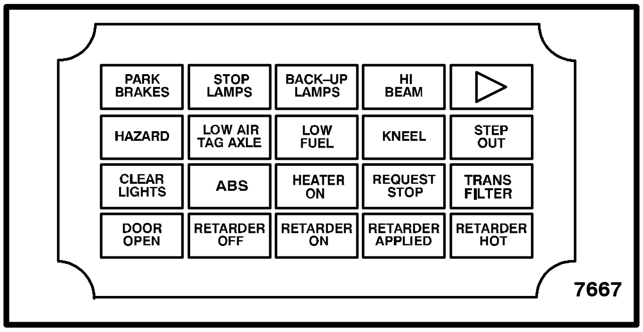
SWITCHES

The paddle or rocker type switches that operate the coach lighting can be found on the LH/RH upper or lower LH panels, and contain serviceable lamps (Figure 4). Switches will contain two lamps, if lettering or symbols appear on both sides of the throw.

OPERATION

AISLE & OVERHEAD LIGHTING

The coach light switch controls the operation of the overhead aisle and/or window lights mounted in the parcel rack mounted lighting. The clearance and identification light switch also illuminates the lower aisle lamps.



PARK BRAKES	STOP LAMPS	BACK–UP LAMPS	HI BEAM	▷
HAZARD	LOW AIR TAG AXLE	LOW FUEL	KNEEL	STEP OUT
CLEAR LIGHTS	ABS	HEATER ON	REQUEST STOP	TRANS FILTER
DOOR OPEN	RETARDER OFF	RETARDER ON	RETARDER APPLIED	RETARDER HOT

7667

Figure 5. Coach High Beam Telltale Warning

HEADLAMPS

Headlight high and low beams are controlled by a foot-operated dimmer switch, located on driver's floor. A high beam indicator is located in the instrument panel's right-hand telltale cluster (Figure 5).

TURN SIGNALS

The LH/RH turn signals are operated by the column mounted selector switch or optional foot switch. When hazard warning switch is actuated, all amber turn lamps should flash.

TAILLAMP ASSEMBLY

Housing Mounted

The red stop/tail lamps in each housing assembly are wired to provide two stoplamps when braking and one running taillamp when headlamps are on (Figure 6). This is double the normal stoplamp illumination and results in an additional operational safety margin in the event of a lamp failure. An additional high-mount stop lamp is provided in the radiator door.

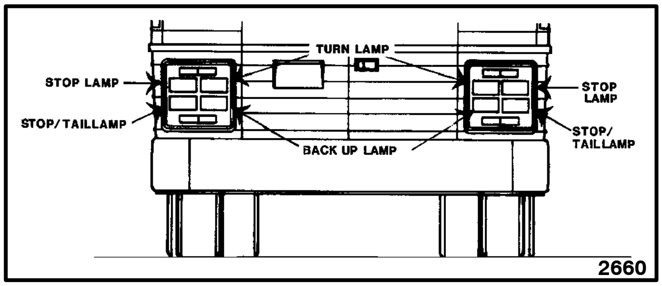
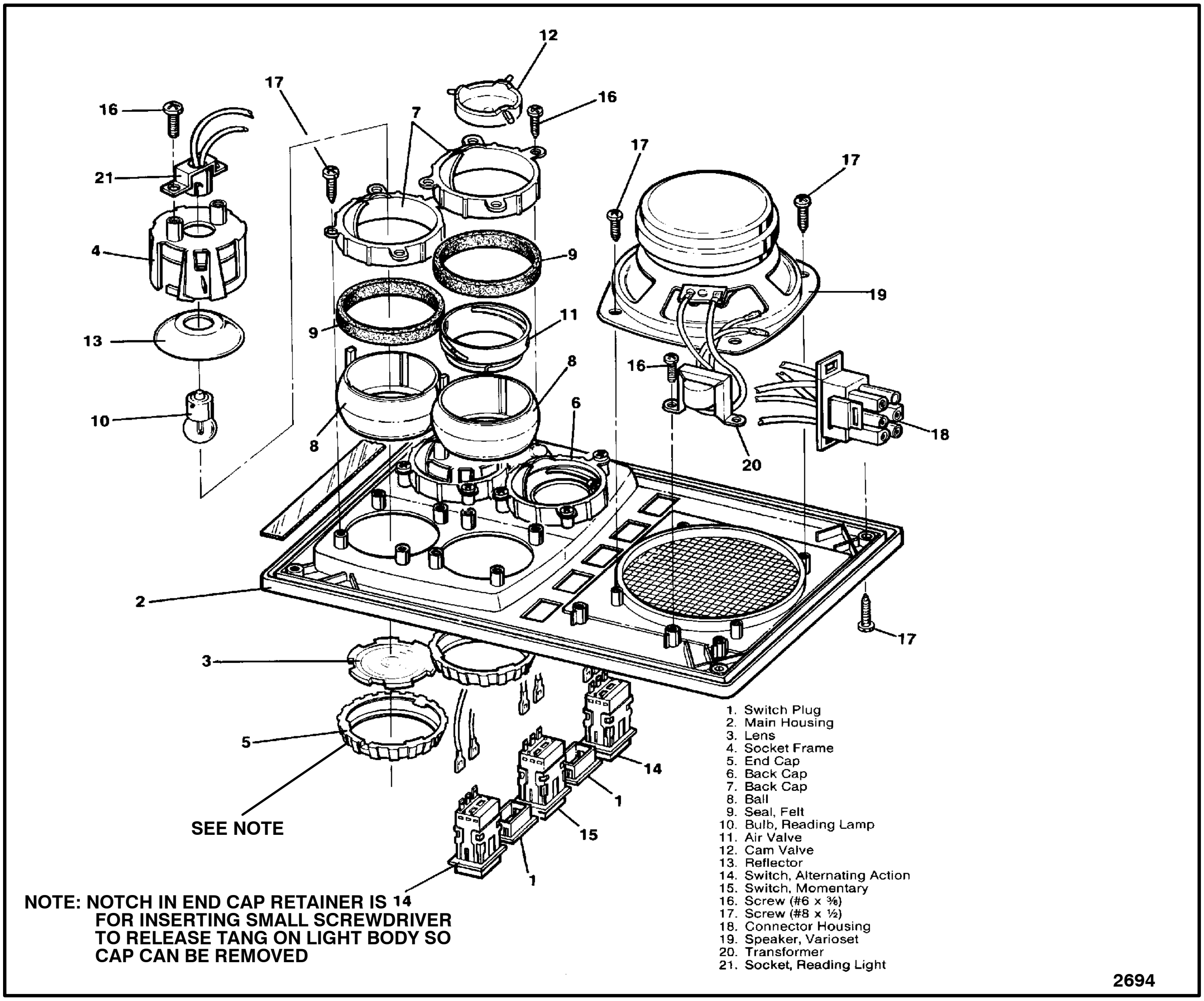

TURN LAMP
STOP LAMP
STOP/TAILLAMP
BACK UP LAMP
STOP LAMP
STOP/ TAILLAMP
2660

Figure 6. Taillamp Assembly

Panel Mounted

The red stop lamp and wraparound tail lamps in each center cluster are wired to provide three stop lamps and two running taillamps in LH/RH center when braking and with headlamps on. A separate high-mounted wraparound stop lamp is provided in the upper cap.


12
17
16
7
16
17
17
21
4
9
19
11
9
13
8
16
6
10
8
18
20
2
17
3
5
14
1
SEE NOTE
15
1
14
1. Switch Plug
2. Main Housing
3. Lens
4. Socket Frame
5. End Cap
6. Back Cap
7. Back Cap
8. Ball
9. Seal, Felt
10. Bulb, Reading Lamp
11. Air Valve
12. Cam Valve
13. Reflector
14. Switch, Alternating Action
15. Switch, Momentary
16. Screw (#6 x ⅜)
17. Screw (#8 x ½)
18. Connector Housing
19. Speaker, Varioset
20. Transformer
21. Socket, Reading Light
2694

NOTE: NOTCH IN END CAP RETAINER IS FOR INSERTING SMALL SCREWDRIVER TO RELEASE TANG ON LIGHT BODY SO CAP CAN BE REMOVED

Figure 7. Parcel Rack Module Components

MAINTENANCE

Clean all interior and exterior lamps with soap and water and a good glass cleaner whenever dirty. For maximum illumination headlamps must be kept clean and proper voltage must be maintained. Low battery, loose or dirty electrical contacts in wiring system and poor ground all contribute to a decrease in voltage. Check wiring and connections regularly and keep battery properly charged.

OVERHEAD LIGHTS

Aisle & Window Lamps

To service the aisle lights, remove the extruded channel cover. On parcel racks without doors, the channel cover is held in place with two screws at the rear corners of the cover. If parcel rack has doors, four screws must be removed to remove channel with door and air cylinder as a unit.

Access to window light tubes is gained by removing lens as follows:

1. Remove the vinyl snap-in molding by inserting a flat tip screwdriver under the lip of the molding (near molding joint).
2. Pry the molding from the housing track.
3. Remove lens to expose the bulbs.
4. To replace lens, first position lens in the housing groove.
5. Then position molding in the housing track and push up to snap lock molding.

Service Module Lamps

The passenger service module is attached to the underside of the luggage rack with four screws. Remove the screws to allow the module to drop down and provide access to the reading light, vent control, switches, speaker and wire connections (Figure 7).

The reading lamps have 28-volt, 1000-hour, 10w bulbs. The bulbs are mounted in single-contact bayonet sockets with leads to accept a G-6 bulb. To change the bulbs, Insert a small screwdriver into the slot on the retaining ring and push in and turn the ring clockwise. DO NOT PRY as this will break the lamp assembly.

HEADLAMPS

Adjustment

Headlamps must be properly aimed to provide maximum allowable road illumination. When using mechanical aimers, follow manufacturer’s instructions.

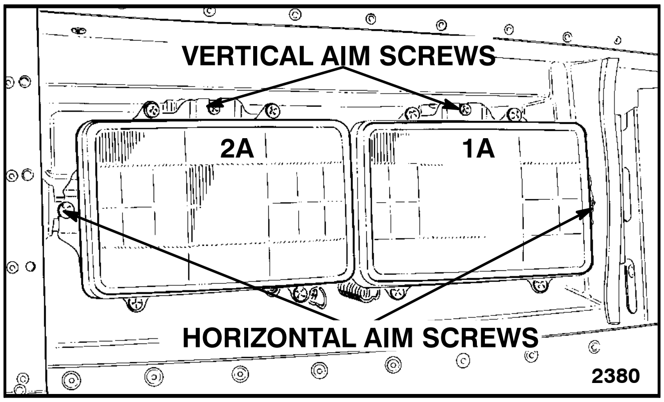

VERTICAL AIM SCREWS
2A
1A
HORIZONTAL AIM SCREWS
2380

Figure 8. Height Aim Screws

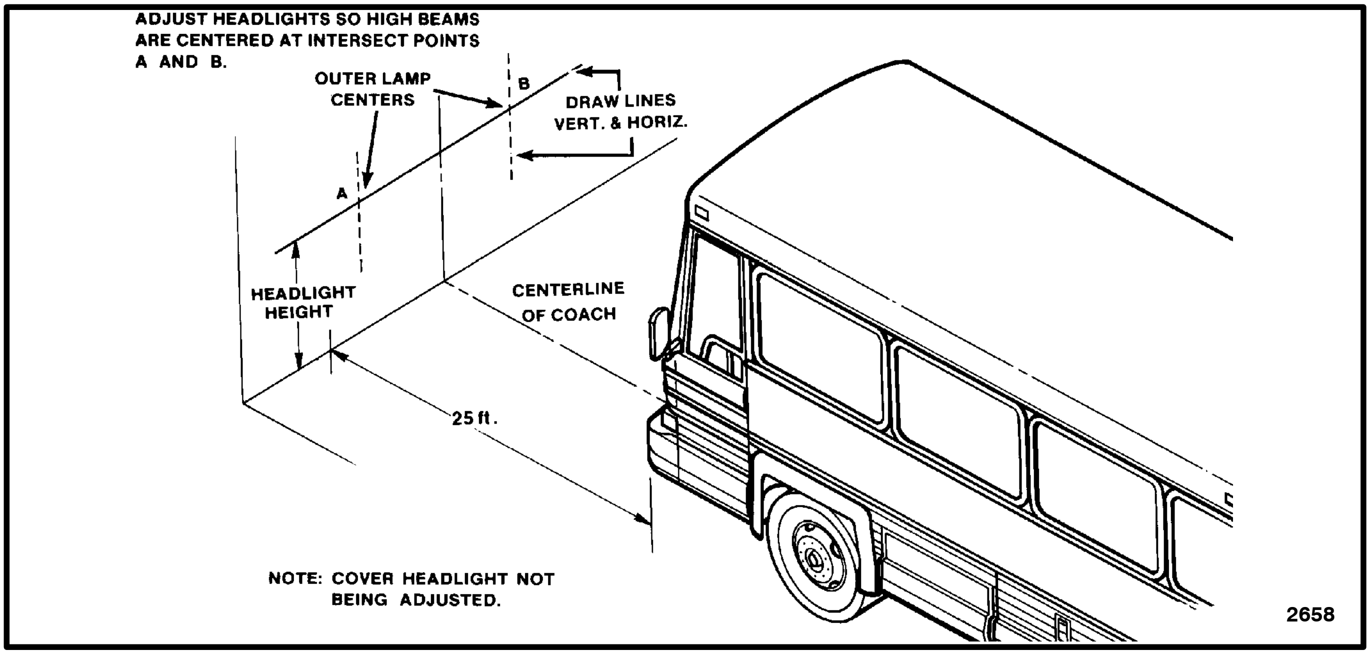

ADJUST HEADLIGHTS SO HIGH BEAMS ARE CENTERED AT INTERSECT POINTS A AND B.
OUTER LAMP CENTERS
B
DRAW LINES VERT. & HORIZ.
A
HEADLIGHT HEIGHT
CENTERLINE OF COACH
25 ft.
NOTE: COVER HEADLIGHT NOT BEING ADJUSTED.
2658

Figure 9. Headlight Adjustment Diagram

Horizontal and vertical aiming of each sealed beam unit is provided by two adjusting screws which move the mounting ring in the body against the tension of the coil spring (Figure 8). There is no adjustment for focus since the sealed beam unit is set for proper focus during manufacturing assembly.

If mechanical equipment is not available, make adjustments as described below (Figure 9).

NOTE: Headlight aiming can be performed without removing headlight bezels.

1. Place vehicle on level floor so headlights are 25 feet (7.6 m) from a smooth surface preferably of light color. A door or wall is suitable. Centerline of vehicle should be perpendicular to this vertical surface.
2. Draw a horizontal line on the vertical surface at height of light center. Locate the point on this horizontal line at which the projected centerline of the vehicle intersects. Measure the distance between lamp centers and divide this distance equally on either side of the center mark. Then draw two vertical lines directly ahead of each light center.
3. Switch on high beams and cover one light while adjusting the other.
4. When aiming headlights, if the beam appears distorted, a new sealed beam unit must be installed to correct this condition.
5. After headlight is properly aligned, cover it and proceed in the same manner as above with opposite light.

Replacement

1. Remove screws attaching the headlight bezel to the front panel and remove the bezel.
2. Remove screws attaching the sealed-beam unit retaining ring to the mounting ring.

NOTE: Do not disturb headlight adjusting screws.

3. Remove sealed-beam unit and disconnect the wiring connector at the back of the unit.
4. Connect wiring connector at the back of the sealed-beam unit. Position the unit in the mounting ring with molded lens number at top.
5. Install retaining ring over lens and secure with screws.
6. Install headlight bezel and adjust if necessary.

NOTE: Headlight aim should be checked after installing a new sealed-beam unit.

TURN SIGNALS

Front Replacement

1. Remove screws attaching the headlight bezel to the front panel and remove the bezel.
2. Remove screws attaching the turn signal housing to body to gain access to rear bulb socket.
3. Twist socket counter-clockwise to remove from housing.
4. Remove bulb from socket by pushing in and turning counter-clockwise.

Side Replacement

1. Remove screws attaching the lens guard and light body to coach.
2. Remove guard, body, lens and gasket to gain access to bulb and socket assembly.
3. Remove bulb from socket by pushing in and turning counter-clockwise.

Rear Replacement

Refer to the procedures used in replacement of the taillamp bulbs that follow.

TAILLAMPS

The taillight assembly housings (stop, tail, turn and back-up) have removeable socket assemblies with either a cam-lock or tab-lock configuration. The new panel mounted assemblies have tab-lock sockets, which cannot be removed by turning. Twisting a tab-lock socket to remove it will damage the housing. Refer to the applicable replacement procedure for each type housing.

NOTE: The high-mounted wraparound stop, square turn signal and square stop/taillamp assembly bulb replacement can only be performed by removing the exterior lens. Only the center cluster's wraparound stop/taillamp bulb may be replaced from the rear of the housing.

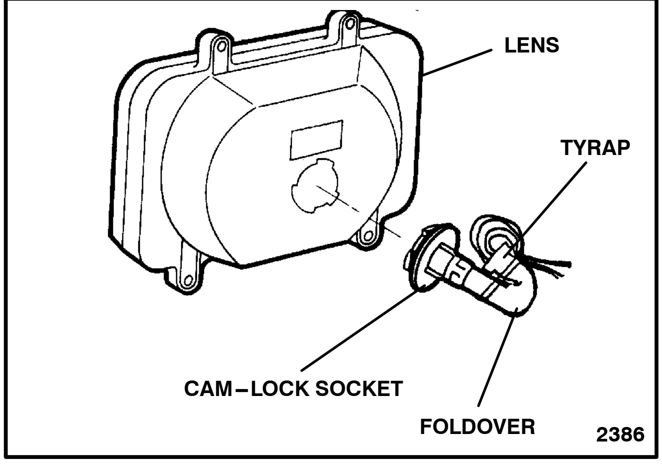


Figure 10. Cam-Lock Bulb Socket

Replacement (Cam-Locking)

1. Open taillight doors to gain access to housing assemblies.

2. Twist socket counter-clockwise to remove from housing (Figure 10,)

3. Remove bulb from socket by pushing in and turning counter-clockwise.

4. Replace bulb, align locking tabs of socket and insert into housing. Twist socket clockwise to engage tabs.

Replacement (Tab-Locking Front)

1. Remove screws attaching the lens to housing and remove.

2. Remove bulb from socket by pushing in and turning counter-clockwise.

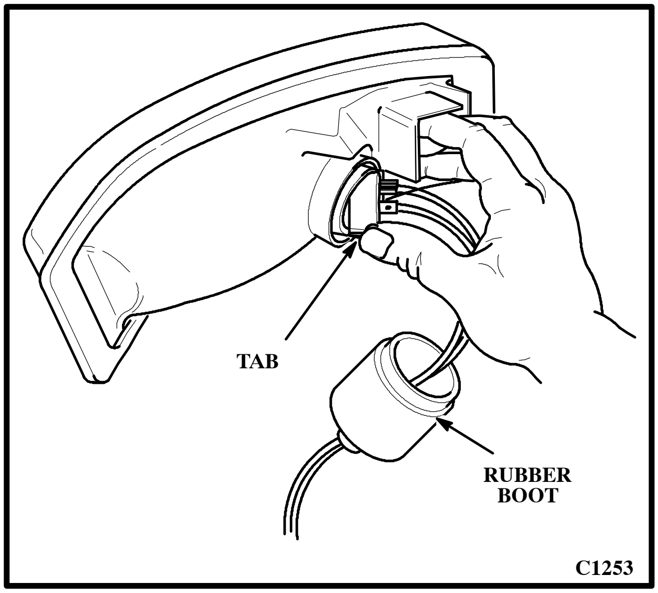


Figure 11. Bulb Removal (Locking Tab)

Replacement (Tab-Locking Rear)

1. Gain access to the back of housing assembly.

2. Slide rubber boot off socket and down harness to expose tab-lock socket.

3. Place thumb on outside of tab with fingers in housing pocket, and gently press in on tab to release from housing (Figure 11).

4. Remove bulb from socket by pushing in and turning counter-clockwise.

NOTE: When replacing bulbs, it is recommended that anti-corrosion grease (Quaker State NYK-77) or equivalent) be used in each lamp socket.

REFLECTORS

Periodic maintenance of the reflector lens or reflective tape is important, since these offer a safety factor when the coach is parked without other lighting in operation.

SWITCHES

To service the switch lamp the cover on the switch must be removed. The covers are the snap-in type and undue pressure on them during removal may damage or break them or the switch housing. The lamps are removed from the housing by pulling up on the ejector tab that is built into the housing. The tab is recessed into the housing, making it difficult to grasp. A tool (20-361) has been developed to aid in removing the cover and for pulling up the lamp ejector tab to a position where it can be grasped with the fingers.

To remove the cover, insert the tool end into the small, shallow groove in the end of the cover (Figure 12) and pull the cover free; do not pry against the upper lip of the housing or the lip may crack.

Engaging the ejector tab, and pulling up with the tool. grasp the tab with the fingers and pull on it firmly until the lamp pops out (Figure 13).

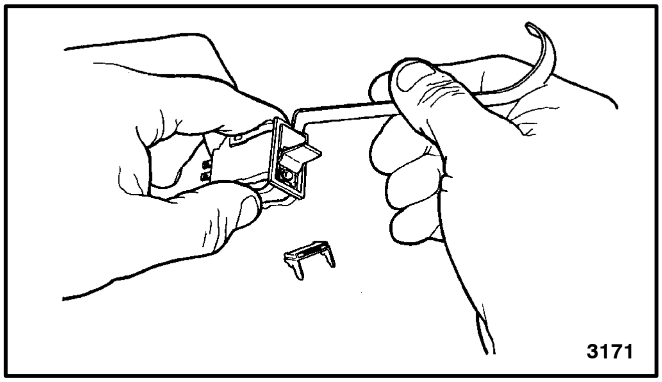


Figure 12. Removing Cover (Paddle-Type)

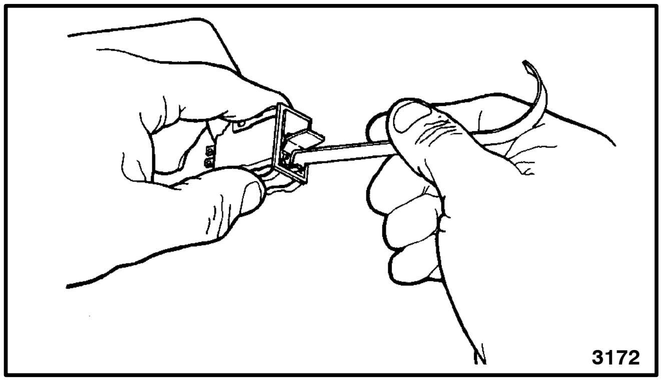


Figure 13. Pull Lamp Ejector Tab (Paddle-Type)

SPECIFICATIONS

TAILLAMPS

Manufacturer (Prior To 45959) .... Trucklite

Manufacturer (Effective With 45959) .... Hella

LIGHT BULB DATA

All exterior bulbs on this coach are 12-volt, all interior bulbs are 24-volt, unless otherwise noted. When replacing light bulbs, special attention must be paid to the voltage rating. The wrong size bulb may overload the system.

EXTERIOR LAMPS	NUMBER	VOLTAGE	VENDOR
Headlamps - High Beam (Inner)	H4651	12V	Sylvania 1A1
Headlamps - Low Beam (Outer)	H4739	12V	Wagner 2A1
Turn Signal/Marker Lights (Front Corner)	1157A	12V	GE
Turn Signal Lamps (Side)	1076	12V	GE
Turn Signal Lamps (Rear)	1156	12V	GE
Stop Lamps	1157	12V	GE
Tail Lamps	1157	12V	GE
Backup Lamps	1156	12V	GE
Rear License Plate Lamps	68	12V	GE
Clearance & Identification Marker Lamps	68	12V	GE

INTERIOR LAMPS	NUMBER	VOLTAGE	VENDOR
Step Lamp RH	624	24V	GE
Step Lamp LH	308 (Frosted)	24V	GE
Destination Sign Lamp	F30 T12/WW/RS	24V	GE
Destination Sign Lamp (In-Station)	15T7 DC	115V	GE
Parcel Rack Window Fluorescent Lamps	F40/WW		
Parcel Rack Aisle Fluorescent Lamps	F30 T12/WW/RS		
Generator Discharge (Remote Box)	456	24V	GE
Coolant Recovery Test (Remote Box)	456	24V	GE
Engine Compartment Lamp (Surge Tank)	456	24V	GE
Engine Compartment Lamps	1683	24V	GE
Parcel Rack Running Lamp (Blue)	67	12V	GE/Sylvania
Rear Bench Seat Lamps (Blue)	67	12V	GE/Sylvania
Underseat Aisle Lamps (Blue)	67	12V	GE/Sylvania
Lavatory Occupied Sign (Front Cap)	265	24V	GE
Lavatory Occupied Lamp (Lavatory Wall)	265	24V	GE
Gear Shift Tower	265	24V	GE
Lavatory Main Lamp	1638	24V	GE
Lavatory Night Lamp	1816	12V	GE
Reading Lamps (Parcel Rack)	TMC013/623	24V	GE
Driver's Lamps	TMC013/623	24V	GE
Baggage Compartment Lamps	308 (Frosted)	24V	
Baggage Compartment Lamps (In-Station)	15T7 DC/IF	115V	GE
Rear Junction Box Service Lamp	308 (Frosted)	24V	GE
Switch Panel Illumination Lamps	85	24V	GE/Chicago
Windshield Washer/Wiper Illumination	85	24V	GE/Chicago
ATEC Transmission Shifter Illumination	85	24V	GE/Chicago

INTERIOR LAMPS (Contd.)	NUMBER	VOLTAGE	VENDOR
Turn Signal Indicator Lamp	74	12V	GE
Emergency Brake On Indicator (Red)	74	12V	GE
Hazard Warning Flasher On Indicator (Red)	74	12V	GE
Stop Lamps On Indicator (Amber)	74	12V	GE
Retractable Step Indicator	85	24V	GE/Chicago
Kneeling Feature Indicator	85	24V	GE/Chicago
Trailing Axle Indicator	85	24V	GE/Chicago
Low Water Level Indicator	85	24V	GE/Chicago
Low Fuel Level Indicator	85	24V	GE/Chicago
Fire Alarm Indicator	85	24V	GE/Chicago
Air Conditioning On Indicator (Red)	85	24V	GE/Chicago
Low Oil Indicator (Red)	85	24V	GE/Chicago
Not Gen. Indicator (Red)	85	24V	GE/Chicago
Lavatory Emergency Indicator (Amber)	85	24V	GE/Chicago
Low Air Indicator (Red)	85	24V	GE/Chicago
Hot Engine Indicator (Red)	85	24V	GE/Chicago
Back-Up Lamps On Indicator (Green)	85	24V	GE/Chicago
High Beam Headlamps On Indicator (Blue)	85	24V	GE/Chicago
Low Coolant Recovery Indicator	85	24V	GE/Chicago
3N124 Protection Indicator	85	24V	GE/Chicago
Tachometer (Sigmanetics)	356	24V	GE
Tachometer (Dixson)	1864	24V	GE
Speedometer Lamp (Sigmanetics)	356	24V	GE
Speedometer Lamp (Dixson)	1864	24V	GE
Air Gauge (Small)	1820	24V	GE
Air Gauge (Large)	456	24V	GE
Oil Pressure Gauge	1829	24V	GE
Fuel Gauge	1829	24V	GE
Voltmeter	1829	24V	GE
Transmission Temperature Gauge	1829	24V	GE
Tachograph (Sangamo)	1895	24V	GE
Tachograph (Argo)	8-854-238697	24V	Argo

SECTION 7J

ELECTRICAL SCHEMATICS

CONTENTS OF THIS SECTION

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General Description 7J-1
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Maintenance 7J-2

GENERAL DESCRIPTION

This electrical schematics section contains basic and optional wiring diagrams used on the D series coaches. The section also contains circuit identification and stud location information of the various electrical junction boxes. An “Electrical Schematic Symbols Key” and “Schematic Index” are provided for reference and convenience.

Wiring diagrams and schematics for a specific electrical systems should be careful study to determine the source and flow of current through each electrical circuit. When a circuit is thoroughly understood, a point-to-point check can be made with the aid of the applicable wiring diagram. Any circuit may be tested for continuity or shorts with a suitable volt-ohmmeter.

NOTE: All stud locations and diagrams found in this section are based on the latest available information at the time of publication. Electrical schematics are subject to revision without notice.

COMPONENTS

SCHEMATIC INDEX

The schematic index is divided into separate groups to quickly and easily find the desired wiring diagram. Each group has its individual schematics alphabetically listed under the group header. Each schematic has a brief title that should appropriately describe that schematic and list the page on which it can be found. Additional notations in parenthesis following each schematic title provides specific information to that diagram.

NOTE: The individual schematic title block will give a more detailed description. The schematics index also contains junction box decals and cable run diagrams.

The schematic index should be used to locate the appropriate wiring diagram. The eleven schematic group index headers and a brief description of what would be included are as follows:

Electro-Mechanical Systems – Engines; Transmissions; Starting & Charging; Road Speed Generator; Engine Hourmeter, etc.

Air Operated Systems – Entrance Door; Retractable Step; Kneeling; Unloading; Retracting; Self-Steer Trailing Axle, etc.

Heating & Air Conditioning Systems – A/C Hourmeter; Auxiliary Heater; A/C Compressor Interlock, etc.

Audio & Video Systems – Speakers; Public Address; Audio & Video, etc.

Instrument Panel & Gauges – Speedometers; Voltmeters; Dash Illumination, etc.

Junction Box Decals – Front Junction; Rear Junction; A/C & ATEC/DDEC Junction, etc.

Coach Lighting – Exterior Headlamps; Taillamps, etc. Interior In-station Lighting; Lavatory; Parcel Racks, etc.

Master Wiring Diagrams – U.S.; Canadian, etc.

Miscellaneous Wiring Diagrams – Anti-Theft; Keyed Ignition; Motorized Blinds, etc.

Signals & Alarms – Coolant; Fire; Air, etc.

JUNCTION BOX CONNECTIONS

Stud location and circuit identifiers are divided into four groups, which represent the four junction or remote boxes. Stud numbers listed below each junction or remote box header corresponds to the number shown on that stud board. Several stud locations will show as “SPARE” or not in use.

The front, rear and A/C junction boxes have decals affixed to their inside covers that show component and stud locations. Junction box stud numbers and circuit listings are shown later in this section. The four junction and remote box descriptions and locations are as follows:

Front Junction Box

The front junction box is the largest of the three main boxes. This box is located below the driver's window and contains either an 80 or 100 stud terminal block. It also contains a number of circuit breakers, relays and solenoids associated with engine function, HVAC, lights, horn, speed switch, etc. The front junction box contains all audible warning buzzers or alarms, and the audio equipment for public address and entertainment systems. All instrument panel functions are routed through this junction box.

A/C DDEC & ATEC Junction Box

The A/C DDEC & ATEC junction box is located on the ceiling on the #1 LH baggage compartment. This box contains a number of main circuit breakers and relays associated with HVAC systems. The ATEC and DDEC diagnostic plugs are routed through this junction box and the ATEC ECU is mounted here also.

NOTE: Early model 102DL3 coaches had this junction box located in the #3 RH baggage bay.

Rear Junction Box

The rear junction box is the smallest of the three main boxes. This box is located at the front LH rear side service door opening and contains a 65 stud terminal block, a number of circuit breakers and relays associated with engine function, starting and charging circuit, air system, remote box etc. All ATEC and DDEC circuits are routed through this junction box.

NOTE: Some studs locations used with DDEC ll may no longer be used with DDEC lll engine installations.

Remote Engine Control Box

This box is located on the LH front ceiling in the engine compartment. The box contains remote engine start controls and coolant recovery controls.

MAINTENANCE

TROUBLESHOOTING PROCEDURES

For an accurate diagnosis of any electrical problem, it is necessary to follow a step-by-step troubleshooting procedure. First, verify the problem by operating the suspected circuit. Once the problem area is verified, then refer to the wiring schematic of the problem circuit.

Next, trace the circuit and redraw it if necessary. This will help to identify the connections, splices, grounds and components in the troubled circuit. After tracing the circuit, systematically test for faulty components, connections, or grounds to isolate the problem.

When the problem is isolated and a particular element of the circuit is determined to be the cause of the problem, make the necessary repair and operate the circuit to verify the repair.

Open Circuits

Many electrical system failures are caused by an open circuit. An open circuit is one in which power flow stops because of an interrupted or incomplete circuit path. An open circuit is caused by an improper ground, a broken connector, poor terminal contact, a loose or broken wire, an open or faulty component, or a circuit breaker or fuse opened by a short or overload.

Testing to isolate an open circuit can be accomplished by using a jumper wire to bypass a suspected open element. If the circuit operates with the jumper in place when power is applied, then the open is in the segment of the circuit bypassed.

Another procedure to pinpoint an open in a circuit is to test for power along the circuit, using a test light. If the test light indicates power at one point, then is moved to another where it does not indicate power, the circuit is open between the two points.

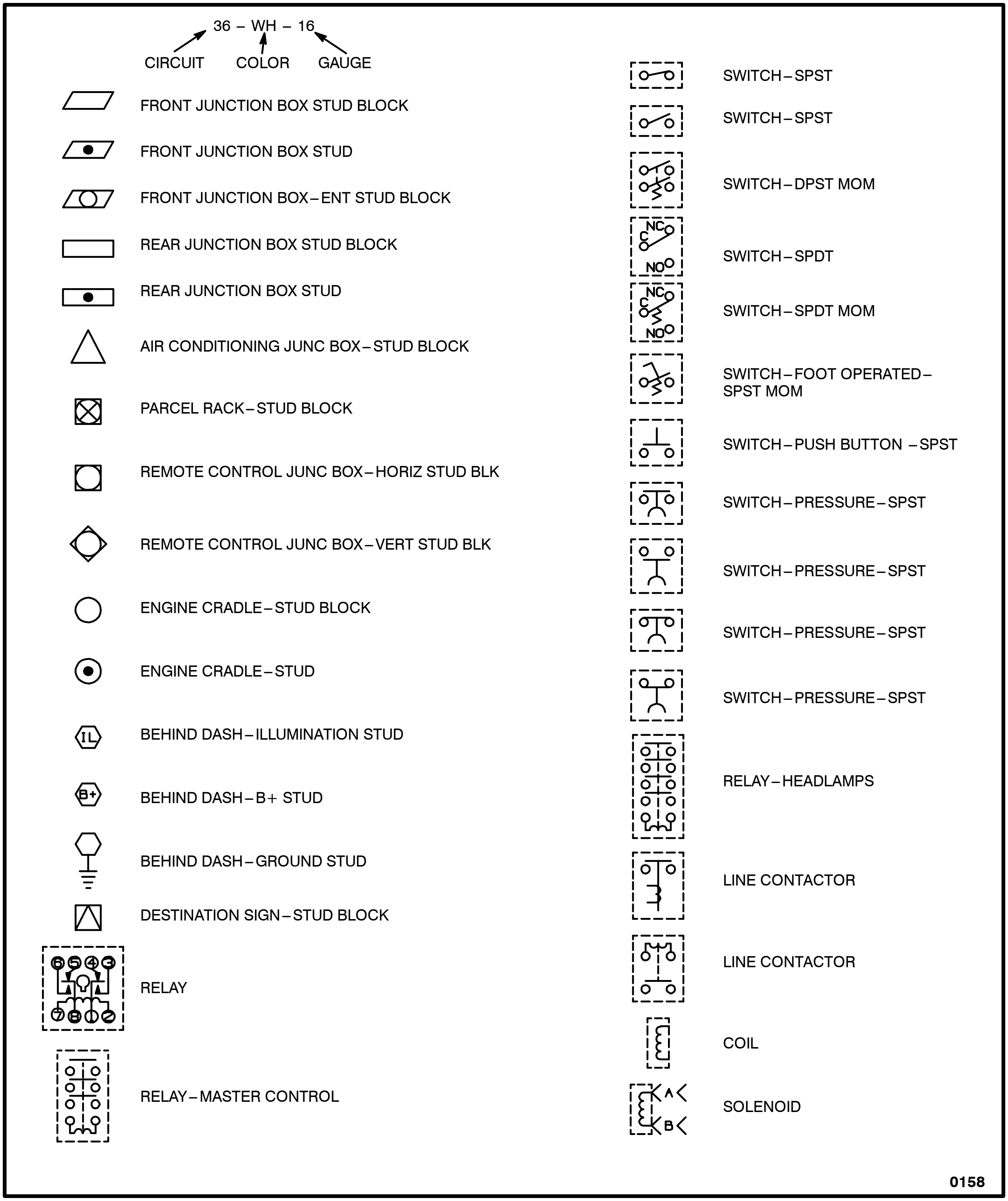
Short Circuits

Many electrical system problems are caused by short circuits. A short circuit is a power circuit that has been grounded before it completes the intended operating circuit.

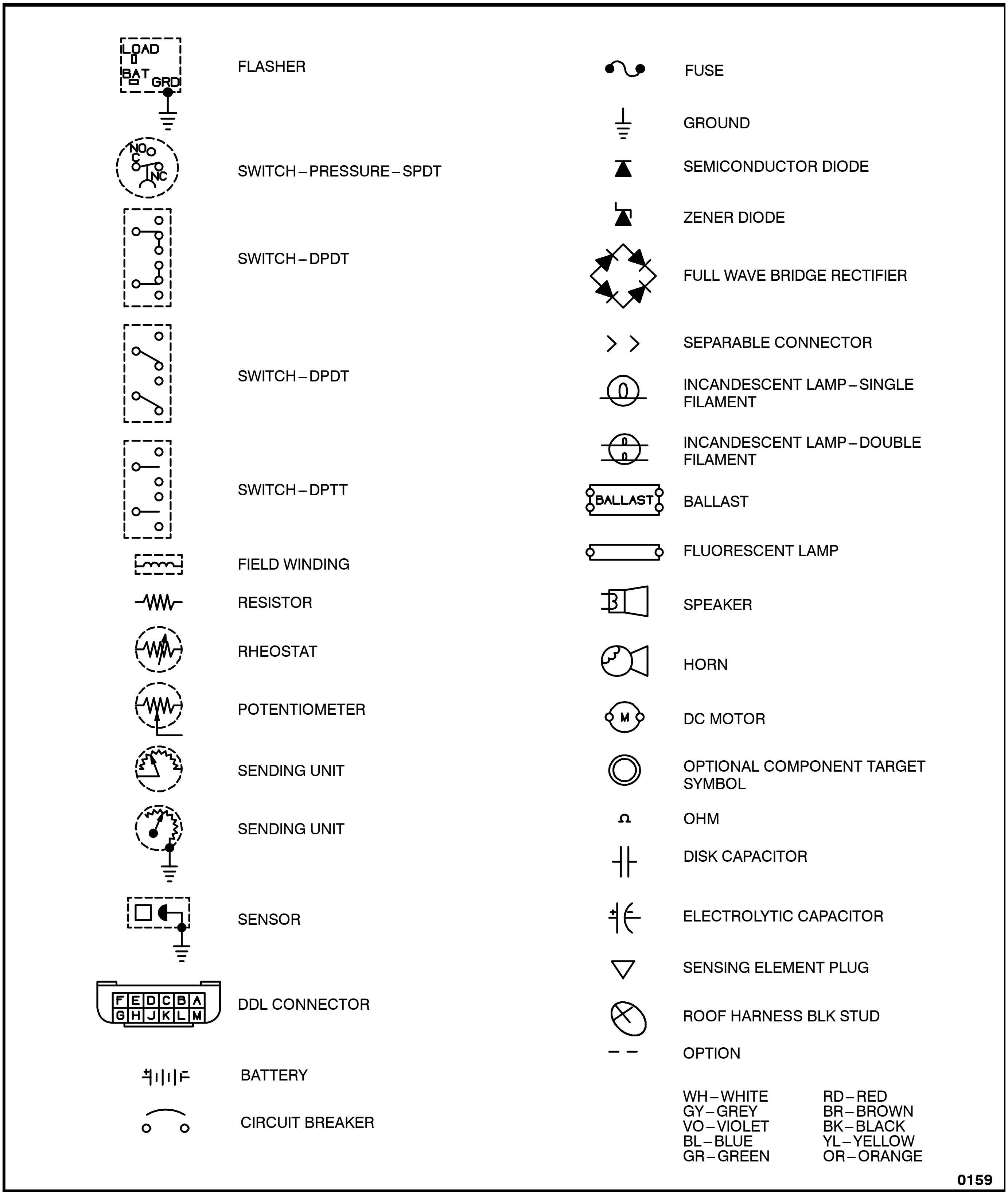
To diagnose a short to ground, use a self-powered test light to test for continuity to ground. First, disconnect the circuit from power and ground. Next, connect the test light between the circuit and ground; the test light will glow if the circuit is shorted to ground. To isolate the short, open elements of the circuit one at a time until the light goes out. The short is in the last element opened or in the segment of the circuit beyond the last element opened. To pinpoint the short, test each element of the isolated segment.

A tripped circuit breaker or a blown fuse usually indicates a short to ground or overloaded circuit. Use a test light to isolate the short. First, turn “OFF” all elements of the circuit receiving power through the circuit breaker or fuse and disconnect all loads. Turn “ON” the power to the fuse, then connect one lead of the test light to the power supply side of the circuit protector and the other lead to ground; the light should indicate power. Disconnect the ground lead of the test light and connect it to the load side of the fuse. If the light is “OFF”, the short is in the equipment. If the light is “ON”, the short is in the wiring. To pinpoint the short, disconnect circuit elements one at a time until the test light goes “OFF”. The short will be in the segment connecting the last element.

ELECTRICAL SCHEMATIC SYMBOLS KEY


36 – WH – 16
CIRCUIT
COLOR
GAUGE
FRONT JUNCTION BOX STUD BLOCK
FRONT JUNCTION BOX STUD
FRONT JUNCTION BOX–ENT STUD BLOCK
REAR JUNCTION BOX STUD BLOCK
REAR JUNCTION BOX STUD
AIR CONDITIONING JUNC BOX–STUD BLOCK
PARCEL RACK–STUD BLOCK
REMOTE CONTROL JUNC BOX–HORIZ STUD BLK
REMOTE CONTROL JUNC BOX–VERT STUD BLK
ENGINE CRADLE–STUD BLOCK
ENGINE CRADLE–STUD
IL
BEHIND DASH–ILLUMINATION STUD
B+
BEHIND DASH–B+ STUD
BEHIND DASH–GROUND STUD
DESTINATION SIGN–STUD BLOCK
6 5 4 3
7 8 1 2
RELAY
RELAY–MASTER CONTROL
SWITCH–SPST
SWITCH–SPST
SWITCH–DPST MOM
NC
C
NO
SWITCH–SPDT
NC
C
NO
SWITCH–SPDT MOM
SWITCH–FOOT OPERATED–SPST MOM
SWITCH–PUSH BUTTON –SPST
SWITCH–PRESSURE–SPST
SWITCH–PRESSURE–SPST
SWITCH–PRESSURE–SPST
SWITCH–PRESSURE–SPST
RELAY–HEADLAMPS
LINE CONTACTOR
LINE CONTACTOR
COIL
A
B
SOLENOID
0158

ELECTRICAL SCHEMATIC SYMBOLS KEY (CONTD.)



FLASHER
SWITCH – PRESSURE – SPDT
SWITCH – DPDT
SWITCH – DPDT
SWITCH – DPTT
FIELD WINDING
RESISTOR
RHEOSTAT
POTENTIOMETER
SENDING UNIT
SENDING UNIT
SENSOR
DDL CONNECTOR
BATTERY
CIRCUIT BREAKER

FUSE
GROUND
SEMICONDUCTOR DIODE
ZENER DIODE
FULL WAVE BRIDGE RECTIFIER
SEPARABLE CONNECTOR
INCANDESCENT LAMP – SINGLE FILAMENT
INCANDESCENT LAMP – DOUBLE FILAMENT
BALLAST
FLUORESCENT LAMP
SPEAKER
HORN
DC MOTOR
OPTIONAL COMPONENT TARGET SYMBOL
OHM
DISK CAPACITOR
ELECTROLYTIC CAPACITOR
SENSING ELEMENT PLUG
ROOF HARNESS BLK STUD
OPTION

WH – WHITE	RD – RED
GY – GREY	BR – BROWN
VO – VIOLET	BK – BLACK
BL – BLUE	YL – YELLOW
GR – GREEN	OR – ORANGE

0159

FRONT JUNCTION BOX CONNECTIONS

Stud	Circuit Number	Color* Codes	Gauge	Volt	Color** Codes	Description
1	26	Orange-Black	16	24	-	Oil Pressure Gauge (Sender)
1	26	-	18	24	White-Black-Orange	Oil Pressure Gauge (Dash)
2	27	Brown	18	24	-	Water Temperature Gauge (Dash)
2	27	-	16	24	Brown	Water Temperature Gauge (Sender)
3	-	-	-	24	-	Spare
4	29	Red-Black	14	24	-	Engine Start Switch Rear
	29	-	18	24	Red-Black	Engine Start Switch (Dash)
5	-	-	-	-	-	Spare
6	807	Blue	16	12	-	Turn Lamp - Left Front
	807	Blue	18	12	Yellow	Left Turn Signal Telltale
7	807	Blue	14	12	-	Turn Lamp - Left Rear and Side
	807	Blue	16	12	-	Turn Signal Relay
8	808	Blue	16	12	-	Turn Lamp - Right Front
	808	Blue	18	12	Red-Yellow	Right Turn Signal Telltale
9	808	Blue	14	12	-	Turn Lamp - Right Rear and Side
	808	Blue	16	12	-	Turn Signal Relay
10	25	Gray	14	-	-	Not Used
10	25	-	18		White-Violet	Not Used
10	25	Black	16	-	-	Not Used
11	5	White-Red	18	24	-	(Dash)
11	5	White-Red	18	24	-	(Rear)
12	OR	Black	18	24	-	Starter Alert Telltale Light
12	OR	-	18	24	Pink	Starter Alert Telltale Light
13	38	White-Green	18	24	-	Low Air Telltale Light (Press) Switch Front
13	38	-	18	24	White-Green	Low Air Telltale Light (Dash)
13	38	Green	18	24	-	Low Air Telltale Lamp Press Switch Rear
13	38	White-Green	18	24	-	Low Air Telltale Lamp Buzzer
14	3	Black	10	24	-	Load Side of Master Control Relay
14	3	Black	10	24	-	Bus Bar Circuit Breaker Feeder (Front)
14	3	Black	10	24	-	Bus Bar Circuit Breaker Feeder (Rear)
14	29P	-	18	24	Brown	Engine Switch
15	806	Blue	14	12	-	Side Marker Lamps (LH and RH Frontside and Intermediate)
15	806	Blue	16	12	-	Front LH and RH Marker Lamp
16	806	Blue	10	12	-	Load Side of Road Lights Relay
16	806	Blue	14	12	-	Front and Center Clearance and I.D. Lamps
16	806	Blue	10	12	-	Road Lamp Relay Bus Bar (Rear)
17	69	Red-Blue	16	24	-	Not Used
18	47	Red-Yellow	14	24	-	Evaporative Motor Relay Coil
18	47	-	18	24	Red-Yellow	Passenger A/C-Heat Switch
18	47	Red-Yellow	-	24	-	Passenger A/C On Relay
19	812	Blue	16	12	-	Stop Lamp Switch (Primary Service Brake)
19	814	Blue	16	12	-	Backup Lamp Feeder
19	822	Blue	18	12	-	Bulb Test Switch
19	812	Blue	16	12	-	Fast Idle Safety Switch
19	812	Blue	14	12	-	Master Control Relay
20	809	Blue	14	12	-	Stop Lamps
20	809	Blue	18	12	Red-Green	Stop Lamp Telltale Light
20	809	Blue	16	12	-	Primary Service Brake Stop Lamp Switch
20	809	Blue	16	12	-	Secondary Service Brake Stop Lamp Switch
21	28	Brown-Yellow	16	24	-	Lavatory Alarm
21	28	-	18	24	Tan	Lavatory Emergency Telltale Light
21	28	Brown-Yellow	16	24	-	Lavatory Emergency Switch
22	36C	White	18	24	-	Spare
23	22	Black-Yellow	16	24	-	Driver's Lamp
	22	18	-	24	White-Yellow	Driver's Light Switch
24	-	-	-	-	-	Not Used
25	31P	Green-Black	14	24	-	Baggage Compartment Lamps Feeder
25	31	Green-Black	14	24	-	Baggage Compartment Lamp Switch
26	9P	Black-Green	18	24	-	Door Latch Solenoid Valve
26	3	Black	16	24	-	Voltmeter
26	3	-	18	24	Red	B+ Stud (Back of Dash)
26	18P	-	18	24	White-Black-Black	Trailing Axle Unload Switch Feeder
26	3B	Black	16	24	-	Alarm Buzzer
26	3	Black	16	24	-	Fast Idle Relay
27	35	White-Black	18	24	-	Hi-Beam Telltale Lamp
27	35P	White-Black	16	24	-	Headlight-Dimmer Switch Relay
27	35P	-	16	24	White-Black	Headlamp (Hi-Low) Relay
28	33	Red-Black	16	24	-	Feeder-Headlight to Dimmer Switch
28	4B	Black	18	24	-	Road Lamp Relay Coil
28	33R	White-Orange	18	24	-	Headlamp Switch

FRONT JUNCTION BOX CONNECTIONS (Contd.)

Stud	Circuit Number	Color* Codes	Gauge	Volt	Color** Codes	Description
28	33	Red-Black	16	24	-	Headlamp (On) Relay
28	33	Red-Black	16	24	-	Surge Protection
29	63A	Violet	14	-	-	Spare
30	54	Yellow	18	24	-	Heating-A/C Feeder
30	54	-	16	24	Yellow	Passenger A/C (On) Relay
30	54D	-	18	24	Orange	Driver’s A/C Switch Feeder
31	55	Orange	16	24	-	Clock in Dash
32	50	-	16	24	Gray	Fire Alarm Telltale Light
33	7R	Black-White	14	24	-	Right-Hand Reading Lights
33	7R	Black-White	14	24	-	Road Lamp Relay
34	14P	Green-Yellow	16	24	-	A/C Malfunction Telltale
34	14P	-	18	24	Brown	A/C Malfunction Telltale Light
35	53	Black-Blue	16	24	-	Fuel Gauge Sender
35	53A	-	18	24	White-Black-Blue	Low Fuel Level Warning Telltale Light (Optional)
36	36A	White	16	24	-	Additional Lavatory OCCUPIED Light
36	36A	White	18	24	-	Lavatory Door Switch
37	76	White-Green	18	24	-	Driver’s A/C Solenoid
37	76	White-Green	18	24	White-Black-Green	Driver’s A/C Switch
38	30	Brown-White	16	24	-	Alarmstat-Hot Engine Sensor
38	30	Brown-White	16	24	-	Hot Engine Buzzer
38	30	Brown-White	18	24	White-Brown	Hot Engine Telltale Light
39	32	Orange-Green	16	24	-	Jacobs Engine Brake Solenoid DDECII
39	32	-	18	24	Pink	Jacobs Engine Brake Switch
39	583	Black	18	24	-	Jacobs Engine Brake Solenoid DDECIII
40	18	Black-White	16	24	-	Low Air Trailing Axle Solenoid Valve Feeder
40	18	Black-White	18	24	-	Sonalert Beeper
40	18	-	18	24	White-Red-Black	Trailing Axle Unload Switch
41	815	Blue	16	12	-	Back-Up Lamp Ground Return
41	815	Blue	18	12	White	Back-Up Telltale Light
42	16	Black	16	24	-	2-Speed Evaporator Motor Relay
42	16	Black	18	24	-	Driver’s Hi-Low Switch
43	56	Green	16	-	-	Spare
44	37	White-Red	18	24	-	Step Lamp Feeder and Chime Switch
44	37P	-	16	24	White-Red	Step Lamp (Switch)
44	19P	Maroon	16	24	-	Chime Feeder
45	7L	Purple	14	24	-	Left-Hand Reading Lamps
45	7L	Violet	14	24	-	Road Lamp Relay
46	40	Gray	16	24	-	Neutral Relay
46	40	-	18	24	White-Gray	Fast Idle Switch
47	813	Blue	16	12	-	Fast Idle Park Brake Switch
47	813	Blue	18	12	-	Fast Idle Relay
47	813	Blue	18	12	-	Emergency Brake Telltale Light
48	59	-	18	24	White-Black-Red	Jacobs Engine Brake Switch
49	66P	-	18	24	Tan	Heated Mirror Switch (Option)
50	60	Yellow	18	24	-	Alarm Buzzer
50	60	Yellow	18	24	-	Low Oil Pressure Switch
50	60	-	18	24	White-Black-Yellow	Low Oil Telltale Light
51	10	Black-Red	18	24	-	Low Water Level Sensor
51	10	Black	18	24	White-Black-Red	Low Water Telltale Light
52	43SP	-	18	24	Red-Green	Switch Panel Illumination Feeder
52	43P	-	18	24	White-Black-Green	Gauge Illumination Rheostat
52	49	Black	18	24	-	Temperature Controller
52	1	White-Black-Brown	18	24	-	Coach Lamp Switch
52	16	Black	16	24	-	Circuit Breaker #65
53	9	Black-Green	18	24	-	Door Latch Solenoid Valve
53	9G	Black-Green	18	24	-	Door Latching Relay
54	58	Blue	16	24	-	Ether Start
55	804	Blue	10	12	-	12V Power Source
56	979	Black	18	24	-	Jacobs Engine Brake Solenoid
56	61	-	18	24	White-Black-Gray	Jacobs Engine Brake Switch
57	57PR		18	24	-	Parcel Rack A/C Switch
57	57	Yellow-Green	16	24	-	Passenger A/C Relay
57	57	Yellow-Green	16	24	-	Hi-Press Cut Out Switch
57	57	Yellow-Green	16	24	-	A/C Malfunction Telltale
58	-	-	-	-	-	Not Used
59	-	-	-	-	-	Not Used
60	51L	Yellow	14	24	-	Master Control Relay
60	51L	Black	14	24	-	Driver’s Defrost Switch
60	51L	-	14	24	Yellow	Defroster B+ Stud
61	43	White-Green	18	24	-	Gear Shift Illumination
61	43	-	18	24	White-Green	Gauge Illumination Lights

FRONT JUNCTION BOX CONNECTIONS (Contd.)

Stud	Circuit Number	Color* Codes	Gauge	Volt	Color** Codes	Description
61	43	-	18	24	White-Green	Gauge Illumination Rheostat
62	A	Black	18	24	-	Retract Step
63	A	Black	18	24	-	Kneeler
63	5A	Black	16	24	-	Retractable Step
64	E	Red	18	24	-	Retractable Step/Kneeler
65	18A	White-Gray	18	24	-	Retractable Step Relay
66	C	Yellow	18	24	-	Retractable Step Relay (or Kneel Option)
67	-	-	-	-	-	-
68	817	Blue	18	12	-	Hazard Telltale Light
68	817	Blue	18	12	Green	Hazard Switch
68	817	Blue	18	12	-	Turn Signal Switch/Relay
68	817	Blue	18	12	-	Turn Signal Switch/Relay
69	816	Blue	18	12	-	Turn Signal Flasher
69	816	Blue	18	12	Blue	Hazard Switch
69	816	Blue	18	12	-	Turn Signal Relays
70	43S	-	18	24	White-Green	Right-Hand Upper Switch Panel Illumination Lights
70	43S	-	18	24	Green	Left-Hand Upper Switch Panel Illumination Lights
70	43S	-	18	24	White-Green	Dash Illumination Rheostat
71	33RB	Black	18	24	-	Daytime Running Lights
72	14H	White-Green	16	24	-	Compressor Clutch
72	14H	-	18	24	White-Black-Green	A/C Malfunction Telltale Light
73	2P	-	18	24	White-Black-Orange	Not Used
74	2S	-	18	24	Orange	Not Used
75	2R	-	18	24	White-Orange	Not Used
76	36B	White	18	24	-	Spare
77	-	-	-	-	-	Spare
78	12V	Yellow	16	12	-	?
79	18A	White	-	-	-	Transmission Temperature Gauge
80	B	White-Black-Violet	18	24	-	Tag Axle Unload Switch
80	B	White-Black-Brown	18	24	-	Tag Axle Telltale
80	B	Black	18	24	-	Tag Axle Pressure Switch
81	R1	Red-Black	18	24	-	Tachometer
81	Tach	White-Black	18	24	-	Tachometer Signal From A
82	-	-	-	-	-	Spare
83	-	-	-	-	-	Spare
84	-	-	-	-	-	Spare
85	29B	White-Brown	18	24	-	Spare
86	79	Black	18	24	-	Spare
87	103	Orange-White	16	24	-	Right-Hand Speaker (+)
87	RD	Red	18	24	-	Right-Hand Speaker (+)
88	107	Orange-Green	16	24	-	Right-Hand Speaker (–)
88	BK	Black	18	24	-	Right-Hand Speaker (–)
89	104	White-Black	16	24	-	Left-Hand Speaker (+)
89	WH	White	18	24	-	Left-Hand Speaker (+)
90	106	Green-Red	16	24	-	Left-Hand Speaker (–)
90	GR	Green	18	24	-	Left-Hand Speaker (–)
91	HTR4	Black	18	24	-	Heater On Telltale
91	HTR4	Black	16	24	-	Webasto Heater Plug C
92	-	-	-	-	-	Spare
93	-	-	-	-	-	Spare
94	57AC	White-Green	18	24	-	Parcel Rack A/C Switch
94	57AC	White-Green	16	24	-	Parcel Rack A/C Relay
95	77HI	Red-Black	18	24	-	Parcel Rack Blower Switch
95	77HI	Red-Black	18	24	-	Left-Hand Parcel Rack Blower Relay
95	77HI	Red-Black	18	24	-	Right-Hand Parcel Rack Blower Relay
95	77	Red-Black	18	24	-	Parcel Rack A/C Relay (Front Junction Box)
96	77LO	Red-Black	18	24	-	Parcel Rack Blower Switch
96	77LO	Red-Black	18	24	-	Parcel Rack A/C Relay (Front Junction Box)
97	SPEEDO	Black	18	24	-	Speedometer Signal
98	-	-	-	-	-	Spare
99	-	-	-	-	-	Spare
100	-	-	-	-	-	Spare

REAR JUNCTION BOX CONNECTIONS

Stud	Circuit Number	Color* Codes	Gauge	Volt	Description
1	56A	Green	16	24	Spare
2	54	Yellow	14	24	Discharge and Blower Cut-In Relay
2	54	Yellow	14	24	Passenger A/C On Relay
3	810	Blue	16	12	Feeder Left-Hand and Right-Hand Rear Tail Lamps
3	810	Blue	14	12	Marker and Tail Lamps
3	810	Blue	16	12	Roof Clearance I.D. and Marker Lamps
4	809	Blue	14	12	Stop Lamps
4	809	Blue	16	12	Rear Stop Lamps
5	815	White	16	12	Back-Up Lamps
5	815	Blue	16	12	Ground Signal Back-Up Lamps
6	808	Blue	14	12	Rear Right-Hand Turn Lamps
6	808	Blue	16	12	Right-Hand Rear Side and Right-Hand Rear Turn Lamp
7	807	Blue	14	12	Left-Hand Turn Lamps
7	807	Blue	16	12	Left-Hand Rear Side and Left-Hand Rear Turn Lamp
8	45B	Yellow-Red	16	24	Daytime Running Lamps
9	-	-	-	-	Spare
10	27	Brown	16	24	Spare
11	-	-	-	-	Spare
12	29	Red-Black	14	24	Starter Switch
12	29	Red-Black	14	24	Remote Starter Switch
13	12V	Yellow	16	12	?
14	18	Black-White	16	24	Trailing Axle Switch
14	18	Black-White	16	24	Trailing Axle Solenoid Valve
15	29S	Black-White	14	24	Starter Solenoid Relay
15	29S	Green	18	24	Triple Function Protective Device
16	814	Blue	16	12	Back-Up Lamp
16	814	Blue	16	12	Back-Up Lamp Feeder
17	69	Red-Blue	16	24	Reverse Throttle Interlock
18	62P	Green-Black	14	24	Lavatory Dome Lamp and Lavatory OCCUPIED
18	31	Green-Black	16	24	Circuit Breaker #31 (RJB)
18	31P	Green-Black	16	24	Engine Compartment Lamp Switch
19	32	Orange-Green	16	24	Jacobs Engine Brake (Option)
20	5	White-Red	18	24	Not Gen Telltale Front
20	5	White-Red	18	24	Discharge and Blower Cut-In Relay
20	5	White-Red	16	24	Not Gen Light Rear
21	30	Brown-White	16	24	Spare
22	40	Gray	16	24	DDEC Fast Idle Relay
23	25	Gray	14	24	Spare
24	3	Red	18	24	3N124 Protection Device
24	3	Black	10	24	Load Side Master Circuit
24	3	Red	10	24	Rear Master Ckt. Bus Bar
25	3	Black	16	24	Field Relay Coil
25	3	Black	16	24	Neutral Relay Coil
25	4	Green-Red	14	24	Rear Stop and Start Switch Feeder
26	OR	Black	18	24	Starter Alert Telltale
26	OR	Pink	18	24	3N124 Protection Device
27	-	-	-	-	Spare
28	36A	White	16	24	Additional Lavatory OCCUPIED Light
29	HTR3	Black	16	24	Heater On relay
29	HTR3	Black	16	24	Heater Plug B
30	-	-	-	-	Spare
31	10	Black-Red	18	24	Low Water Telltale Lamp
31	10	Black	18	24	Low Coolant Level Relay
32	50	Green-Red	16	24	Fire Detectors (Option)
33	R1	Black-Red	18	24	24V Discharge Relay Feeder & Blower Cut-In Coil
33	TACH	White-Black	18	24	Sigmanetics Tachometer
33	R1	Yellow-Orange	16	24	Alternator
33	R1	Yellow-Orange	18	24	Triple Function Protective Device
34	26	Orange-Black	16	24	Spare
35	-	-	-	-	Spare
36	57	Yellow-Green	16	24	Passenger A/C On Relay
36	57	Yellow-Green	16	24	Hi Pressure Switch
36	57	Yellow-Green	16	24	Condenser Relay
36	57	Yellow-Green	16	24	A/C Malfunction Telltale
37	28P	Brown-Yellow	16	24	Lavatory Emergency Switch
37	28P	Brown-Yellow	16	24	Lavatory Emergency Feeder
38	28	Brown-Yellow	16	24	Lavatory Emergency Switch
38	28	Brown-Yellow	16	24	Lavatory Alarm
39	HTR4	Black	16	24	Plug “C”
39	HTR4	Black	16	24	Heater On Telltale

REAR JUNCTION BOX CONNECTIONS (Contd.)

Stud	Circuit Number	Color* Codes	Gauge	Volt	Description
40	14P	Green-Yellow	16	24	A/C Malfunction Telltale
40	14P	Green-Yellow	16	24	A/C Safety Switches
41	HTR1	Black	16	24	Water Valve Relay
41	58	Blue	16	24	By Pass Valve
42	58	Blue	16	24	Ether Start
43	63A	Violet	14	24	Spare
44	60	Yellow	18	24	Spare
45	-	-	-	-	-
46	29S	Yellow	18	24	Triple Function Protective Device (Option)
46	29S	Yellow	16	24	Neutral Relay
47	36F	Blue	18	12	Triple Function Protective Device
47	36F	Blue	16	24	Field Relay
48	F1	Yellow	12	24	Alternator Field ”F1”
48	F1	Yellow	12	24	Regulator
49	A1	Yellow-Black	12	24	Alternator
49	A1	Yellow-Black	12	24	Field Relay
50	70	Black	16	24	Fuel Priming Pump Switch
50	70	Black	16	24	Fuel Priming Pump
51	60	Yellow	18	24	Spare
52	15B	Red-Black	16	24	Daytime Running Lamps
53	6	Blue-Yellow	16	24	Engine Run Switch Feeder
53	6	Blue-Yellow	16	24	Engine Run Switch
54	6A	Blue-Yellow	16	24	Engine Run Switch
54	6A	Blue-Yellow	16	24	DDEC Ignition Relay
55	-	-	-	-	Spare
56	-	-	-	-	Spare
57	557	Red	18	24	Road Speed Generator
A	18A	Black-White	18	24	Transmission Temperature Gauge
B	B	Black	18	24	Low Air Trailing Axle Telltale Light
B	B	Black	16	24	Tag Axle Pressure Switch
C	-	-	-	-	Spare
D	556B	Yellow	18	24	Cruise Control Signal (Road Speed Generator)
WH	-	-	-	-	Spare
BR	14H	White-Brown	16	24	Compressor Clutch
BR	14H	White-Brown	16	24	Liquid Line Solenoid
GR	38	White-Green	18	24	Low Air Telltale Light
GR	38	White-Green	18	24	Low Air Switch
BK	-	-	-	-	Spare

AIR CONDITIONING JUNCTION BOX CONNECTORS

Stud	Circuit Number	Color* Codes	Gauge	Volt	Description
1	70	White-Green	18	24	Fuel Priming Pump
2	16	Black	16	24	2-Speed Evaporator Motor Assembly
2	16	Black	16	24	Hi-Low Switch
3	31	Green-Black	14	24	Baggage Compartment Lamps
3	31	Green-Black	14	24	Baggage Lamp Switch
4	807	Blue	14	12	Left-Hand Turn Signal Feeder
4	807	Blue	14	12	Left-Hand Side Front Turn Lamp
4	807	Blue	14	12	Left-Hand Side Intermediate Turn Lamps
4	807	Blue	14	12	Left-Hand Side Rear and Rear Turn Lamps
5	808	Blue	14	12	Right-Hand Turn Signal Feeder
5	808	Blue	14	12	Right-Hand Side Front Turn Lamp
5	808	Blue	14	12	Right-Hand Side Intermediate Turn Lamps
5	808	Blue	14	12	Right-Hand Side Rear and Rear Turn Lamps
6	-	-	-	-	Spare
7	56	Green	16	24	Spare
7	56A	Green	16	24	Spare
8	55	Orange	16	24	Clock On Dash
9	806	Blue	14	12	Side Marker Lamp Feeder
9	806	Blue	14	12	Right-Hand Side Intermediate Marker Lamp
9	806	Blue	14	12	Right-Hand Side Front Marker Lamp
9	806	Blue	14	12	Left-Hand Side Intermediate Marker Lamp
9	806	Blue	14	12	Right-Hand Side Front Marker Lamp
10	-	-	-	-	Spare
11	14H	White-Green	16	24	A/C Telltale
11	14H	White-Green	16	24	Liquid Line Solenoid

AIR CONDITIONING JUNCTION BOX CONNECTORS (Contd.)

Stud	Circuit Number	Color* Codes	Gauge	Volt	Description
11	14H	White-Green	16	24	Compressor Clutch
12	70P	Red	16	24	Spare
13	53	Black-Blue	16	24	Fuel Gauge
13	53	Black-Blue	16	24	Fuel Sending Unit
14	47	Red-Yellow	16	24	Evaporator Motor Relay
14	47	Red-Yellow	14	24	Passenger A/C and Heat Switch
15	57	Yellow-Green	16	24	Condenser Motor Relay Coil
15	57	Yellow-Green	16	24	Passenger A/C On Relay
15	57	Yellow-Green	16	24	Condenser Motor Relay

REMOTE CONTROL BOX

(HORIZONTAL BAR)

Stud	Circuit Number	Color* Codes	Gauge	Volt	Description
1	57	Yellow-Green	16	24	Hi-Lo Pressure Switch Feeder
1	57	Yellow-Green	16	24	Passenger A/C On Relay
2	14H	White-Green	16	24	A/C Clutch
2	14H	White-Green	16	24	Liquid Line Solenoid
2	BL	Black	16	24	Hi Pressure Switch
3	14P	Green-Yellow	16	24	Spare
4	814	Blue	16	12	Back-Up Lamp Feeder
4	814	Blue	16	12	Right-Hand Back-Up Lamp
4	814	Blue	16	12	Left-Hand Back-Up Lamp
5	807	Blue	16	12	Left-Hand Turn Lamp
5	807	Blue	16	12	Left-Hand Rear Turn Lamp Feeder
6	815	White	16	12	Back-Up Lamp Ground Signal
6	815	Blue	16	12	Right-Hand Rear Back-Up Lamp
6	815	White	16	12	Left-Hand Rear Back-Up Lamp
7	-	-	-	-	Spare
8	54	Yellow	16	24	Spare
9	6A	Blue-Yellow	16	24	Engine Run Switch
9	6A	Blue-Yellow	16	24	DDEC Ignition Relay
10	SP	Yellow	16	24	Spare

(VERTICAL BAR)

Stud	Circuit Number	Color* Codes	Gauge	Volt	Description
1	811	Blue	16	12	License Plate Lamps
1	811	Blue	16	12	License Plate Lamp Feeder
2	810	Blue	16	12	Right-Hand and Left-Hand Tail Lamp Feeder
2	810	Blue	16	12	Right-Hand Tail Lamp
2	810	Blue	16	12	Left-Hand Tail Lamp
3	809	Blue	16	12	Right-Hand Stop Lamps
3	809	Blue	16	12	Stop Lamp Feeder
3	809	Blue	16	12	Left-Hand Stop Lamp
3	809	Blue	16	12	High Mounted. Stop Lamp
4	31	Green-Black	16	24	Motor Compartment Service Lamps
4	31A	Green-Black	16	24	Surge Tank lamp
4	31	Green-Black	16	24	Rear Junction Box Lamp
4	31	Green-Black	16	24	Service Lamp Switch
5	808	Blue	16	12	Right-Hand Turn Lamps
5	808	Blue	16	12	Right-Hand Turn Lamp Feeder
6	57	Yellow-Green	16	24	Spare
7	63	Blue	16	24	Lavatory Blower Motor
8	63A	Red-Black	16	24	Spare

* All harnesses except driver's instrument panel
** Driver's instrument panel (All 18 gauge)

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80 Stud Panel (Used Prior To April 1993 Production) . . . . 7L-13-1033 (B)
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Rear Junction Box

65 Stud Panel W/DDEC Installation (Effective With 1993 Production) . . . . 7L-13-998 (C)
65 Stud Panel W/Caterpillar Installation (Effective With 1997 Production) . . . . 7L-13-1687 (B)

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Exterior

Headlamps, Side Marker/Turn Signal & Clearance/I.D. Lamps (Effective With 1997 Production) . . . . 7L-13-1991 (C)
Headlamps, Side Marker/Turn Signal & Clearance/I.D. Lamps W/Conversion Coaches (Effective with 1997 Production) . . . . . 7L-13-1246 (C)
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Stepwell, Driver's Parcel Rack & Lavatory Lighting W/Sprague Turn Signal Switch (Effective With March 1995) . . . . 7L-13-2319 (A)
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PART NO.	DESCRIPTION	REV.
7J-8-173	**SAGAMO MECH. TACHOGRAPH**	**A**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

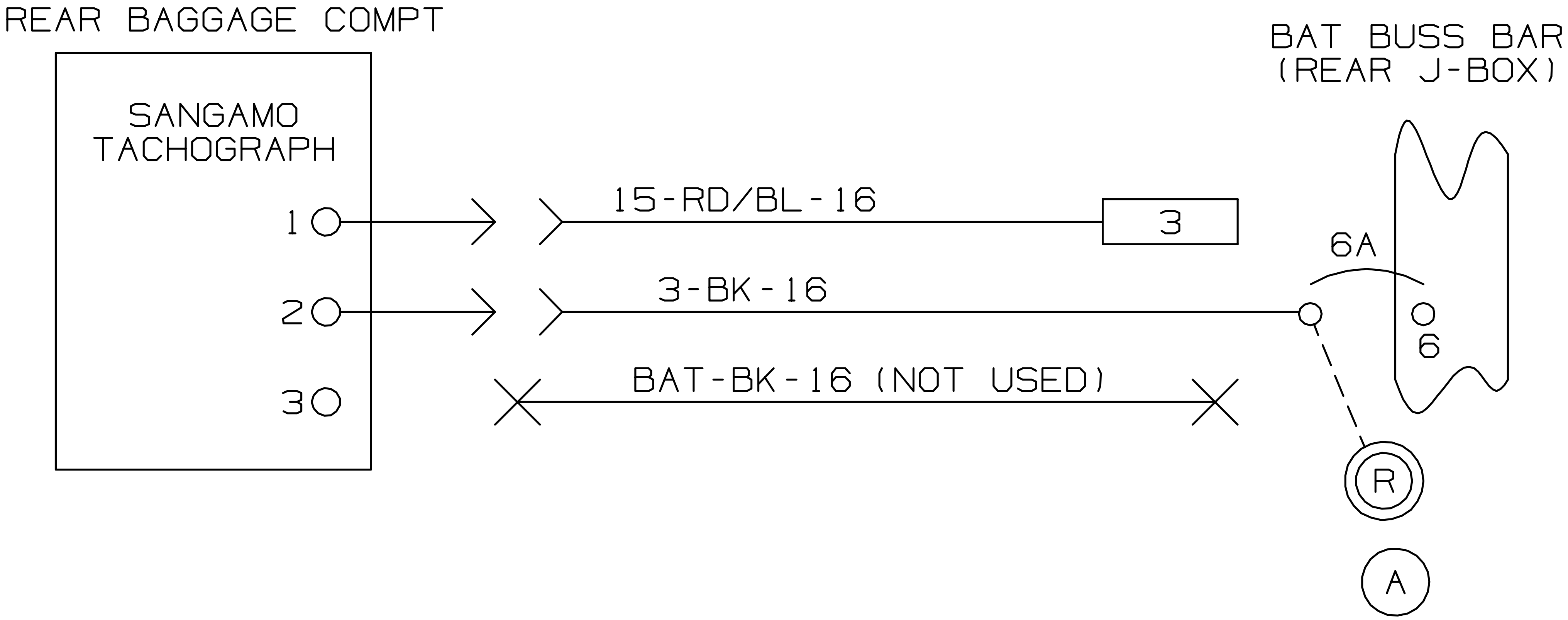
RD–RED
BR–BROWN
BK–BLACK

LEGEND

WIRING DIAGRAM

SAGAMO MECHANICAL TACHOGRAPH

7J-8-173 (REV A)


REAR BAGGAGE COMPT
SANGAMO TACHOGRAPH
1
2
3
15-RD/BL-16
3
3-BK-16
BAT-BK-16 (NOT USED)
BAT BUSS BAR (REAR J-BOX)
6A
6
R
A

PART NO.	DESCRIPTION	REV.
7J-13-178	DRIVER'S READING LIGHT SWITCH	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

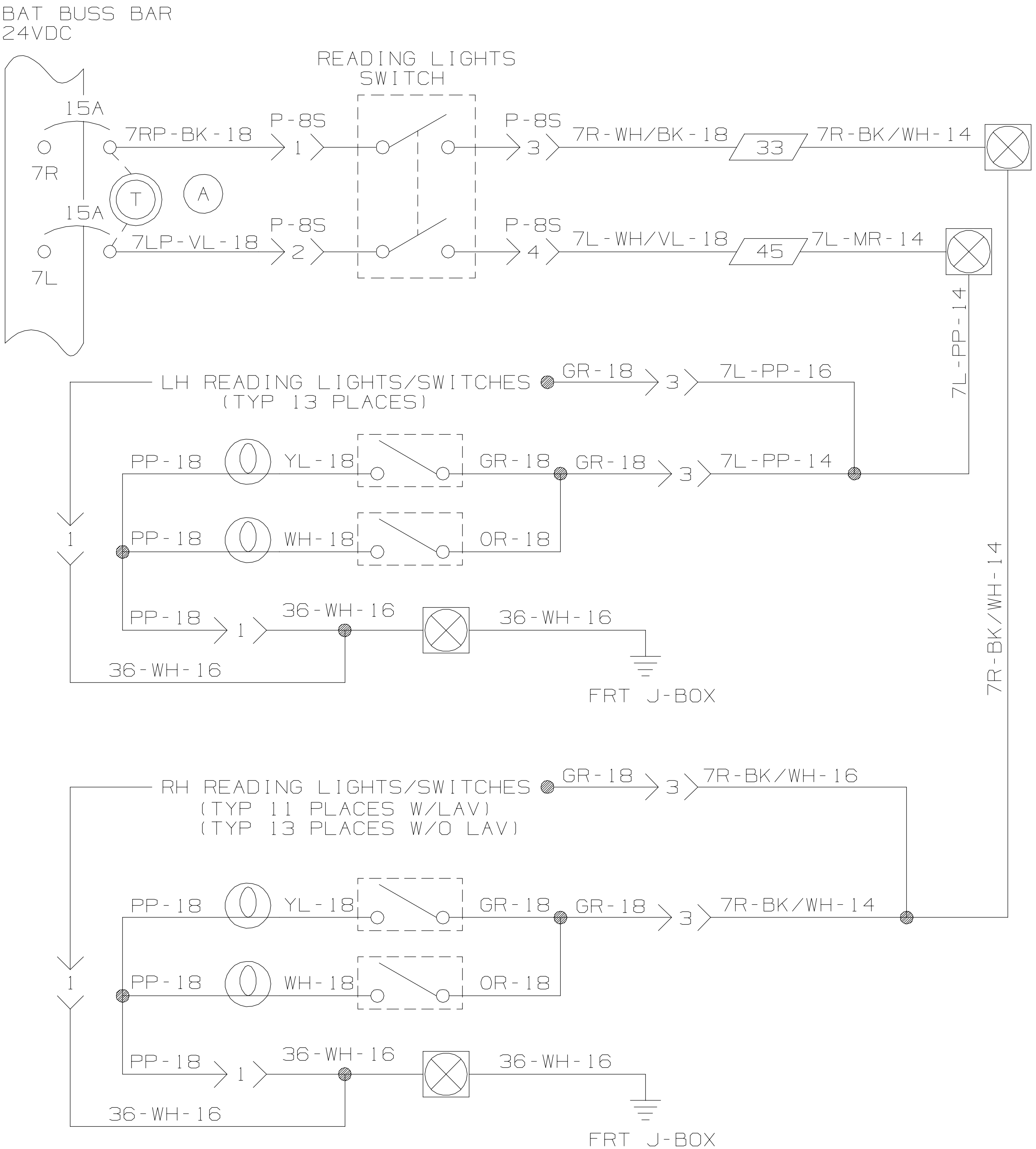
LEGEND

DRIVER'S SEPERATE SWITCH

FOR PASSENGER READING LIGHTS

ALL MODELS

7J-13-178 (REV A)


BAT BUSS BAR
24VDC
15A
7R
15A
7L
T
A
7RP-BK-18
7LP-VL-18
P-8S
1
P-8S
2
READING LIGHTS
SWITCH
P-8S
3
P-8S
4
7R-WH/BK-18
33
7R-BK/WH-14
7L-WH/VL-18
45
7L-MR-14
7L-PP-14
7R-BK/WH-14
LH READING LIGHTS/SWITCHES
(TYP 13 PLACES)
GR-18
3
7L-PP-16
PP-18
YL-18
GR-18
GR-18
3
7L-PP-14
1
PP-18
WH-18
OR-18
PP-18
1
36-WH-16
36-WH-16
36-WH-16
FRT J-BOX
RH READING LIGHTS/SWITCHES
(TYP 11 PLACES W/LAV)
(TYP 13 PLACES W/O LAV)
GR-18
3
7R-BK/WH-16
PP-18
YL-18
GR-18
GR-18
3
7R-BK/WH-14
1
PP-18
WH-18
OR-18
PP-18
1
36-WH-16
36-WH-16
36-WH-16
FRT J-BOX

PART NO.	DESCRIPTION	REV.
7J-13-355	A/C HOURMETER	A

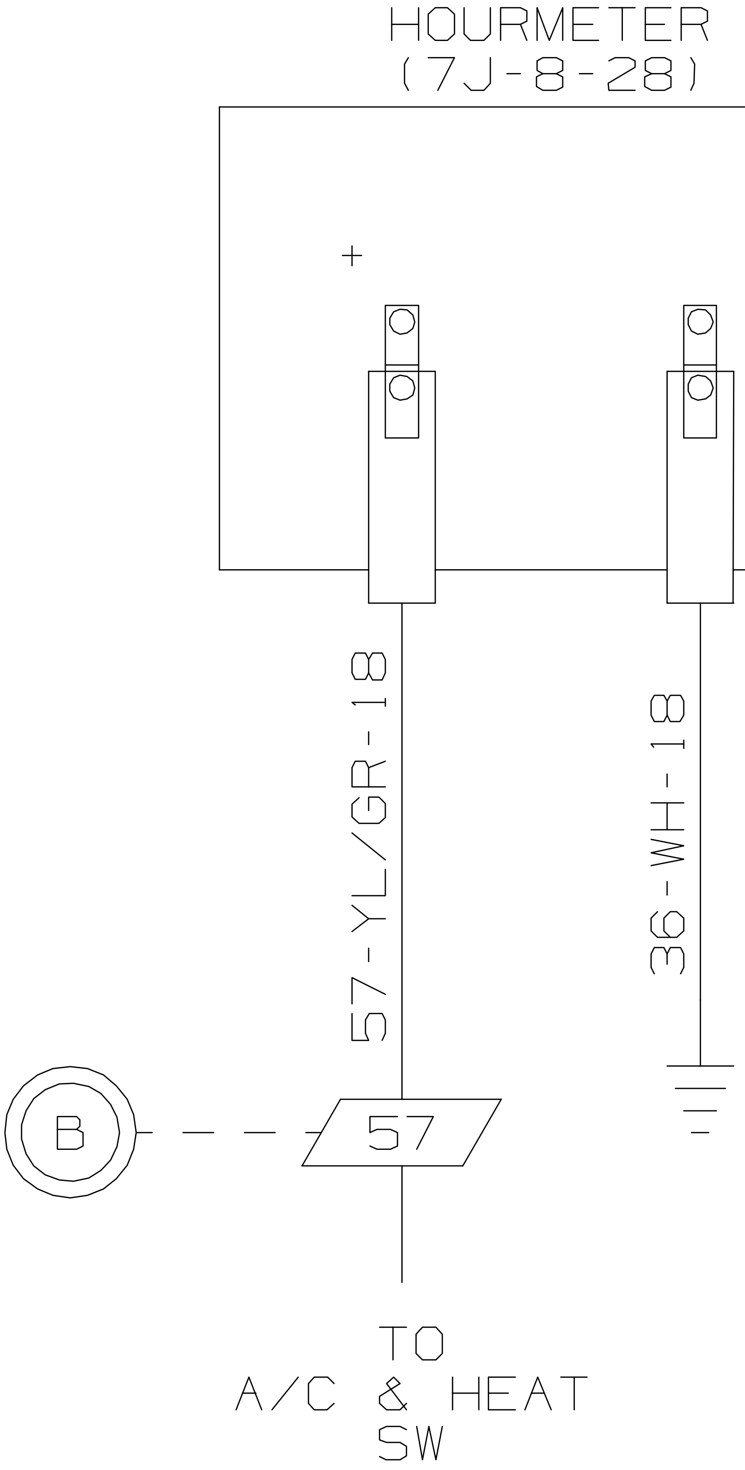
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

A/C HOURMETER
102D3 & 102DL3

7J–13–355 (REV A)


HOURMETER
(7J-8-28)
+
—
57-YL/GR-18
36-WH-18
B
57
TO
A/C & HEAT
SW

PART NO.	DESCRIPTION	REV.
7L-13-86	ENGINE EMERSION HEATER	B

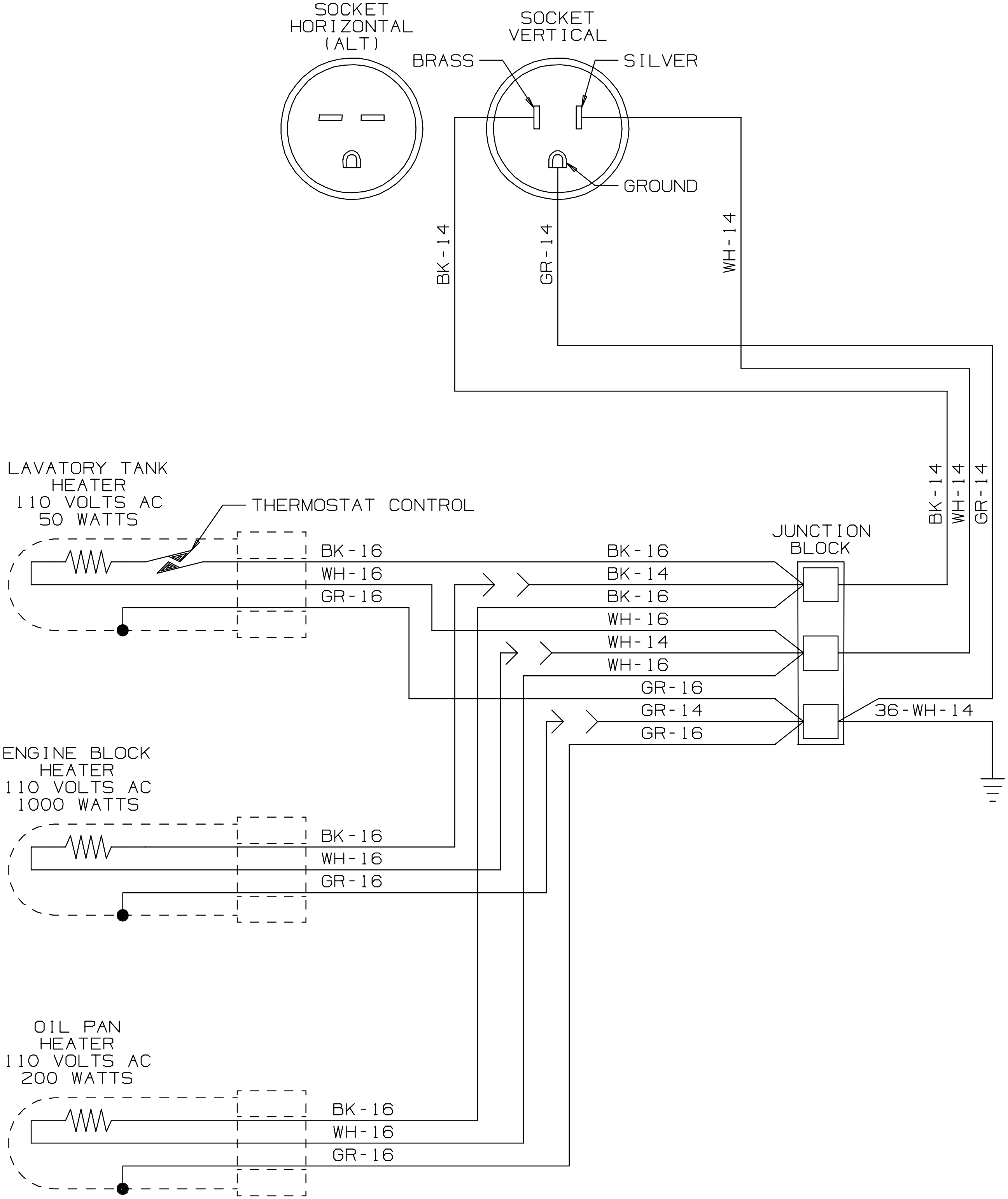
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

ENGINE EMERSION HEATER
102D3 & 102DL3
7L–13–86 (REV B)


SOCKET
HORIZONTAL
(ALT)
SOCKET
VERTICAL
BRASS
SILVER
GROUND
BK-14
GR-14
WH-14
LAVATORY TANK
HEATER
110 VOLTS AC
50 WATTS
THERMOSTAT CONTROL
BK-16
WH-16
GR-16
BK-16
BK-14
BK-16
WH-16
WH-14
WH-16
GR-16
GR-14
GR-16
JUNCTION
BLOCK
BK-14
WH-14
GR-14
36-WH-14
ENGINE BLOCK
HEATER
110 VOLTS AC
1000 WATTS
BK-16
WH-16
GR-16
OIL PAN
HEATER
110 VOLTS AC
200 WATTS
BK-16
WH-16
GR-16

PART NO.	DESCRIPTION	REV.
7L-13-81	PARCEL RACK POWER VENTILATION	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

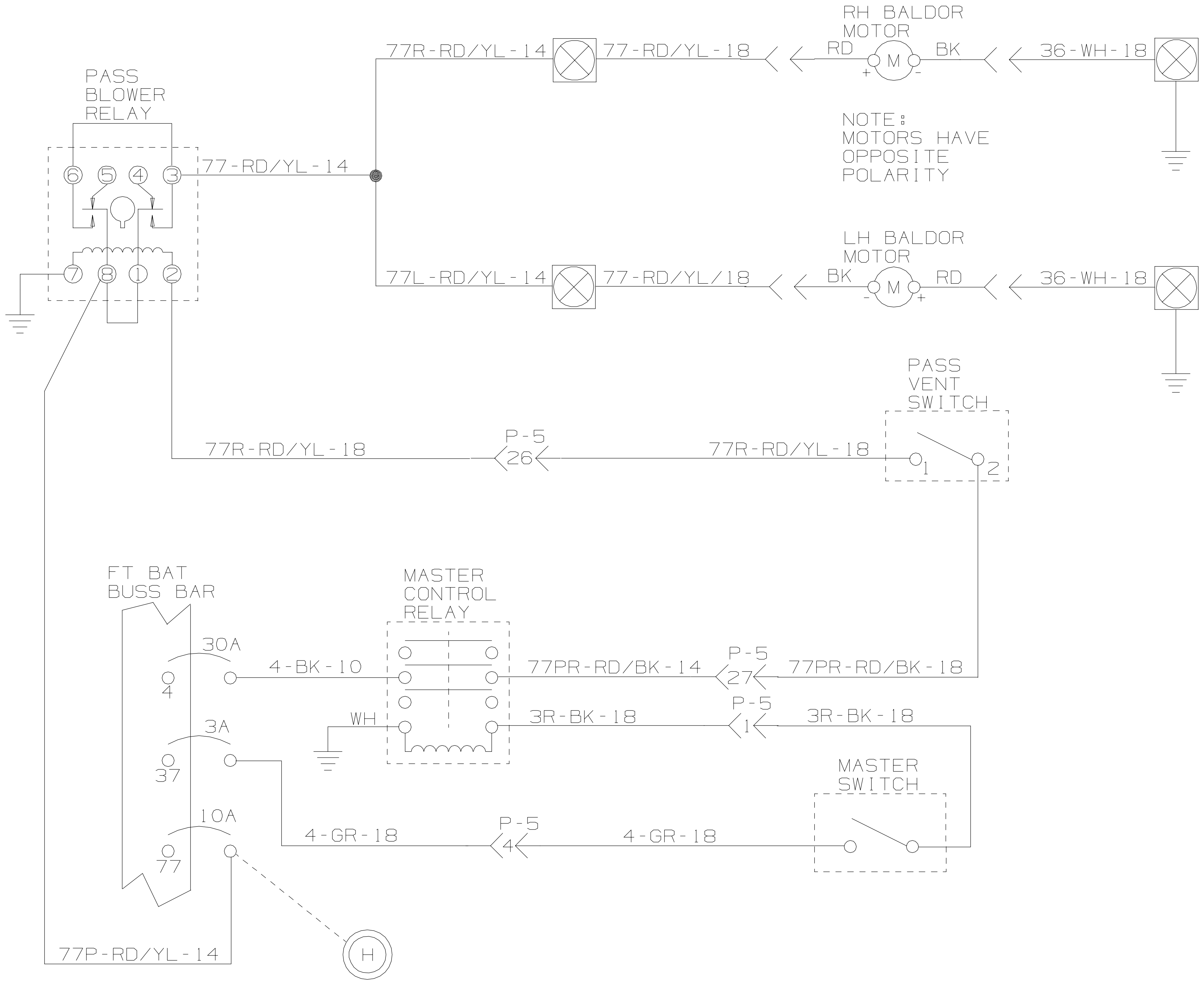
RD–RED
BR–BROWN
BK–BLACK

LEGEND

PARCEL RACK POWER VENTILATION

102DL3

7L-13-81 (REV A)


RH BALDOR MOTOR
RD
+
M
-
BK
77R-RD/YL-14
77-RD/YL-18
36-WH-18
PASS BLOWER RELAY
6
5
4
3
7
8
1
2
77-RD/YL-14
NOTE: MOTORS HAVE OPPOSITE POLARITY
LH BALDOR MOTOR
BK
-
M
+
RD
77L-RD/YL-14
77-RD/YL/18
36-WH-18
PASS VENT SWITCH
1
2
77R-RD/YL-18
P-5
26
77R-RD/YL-18
FT BAT BUSS BAR
30A
4
3A
37
10A
77
MASTER CONTROL RELAY
4-BK-10
77PR-RD/BK-14
P-5
27
77PR-RD/BK-18
WH
3R-BK-18
P-5
1
3R-BK-18
MASTER SWITCH
4-GR-18
P-5
4
4-GR-18
77P-RD/YL-14
H

PART NO.	DESCRIPTION	REV.
7L-13-1771	PARCEL RACK AC POWER SOURCE	A

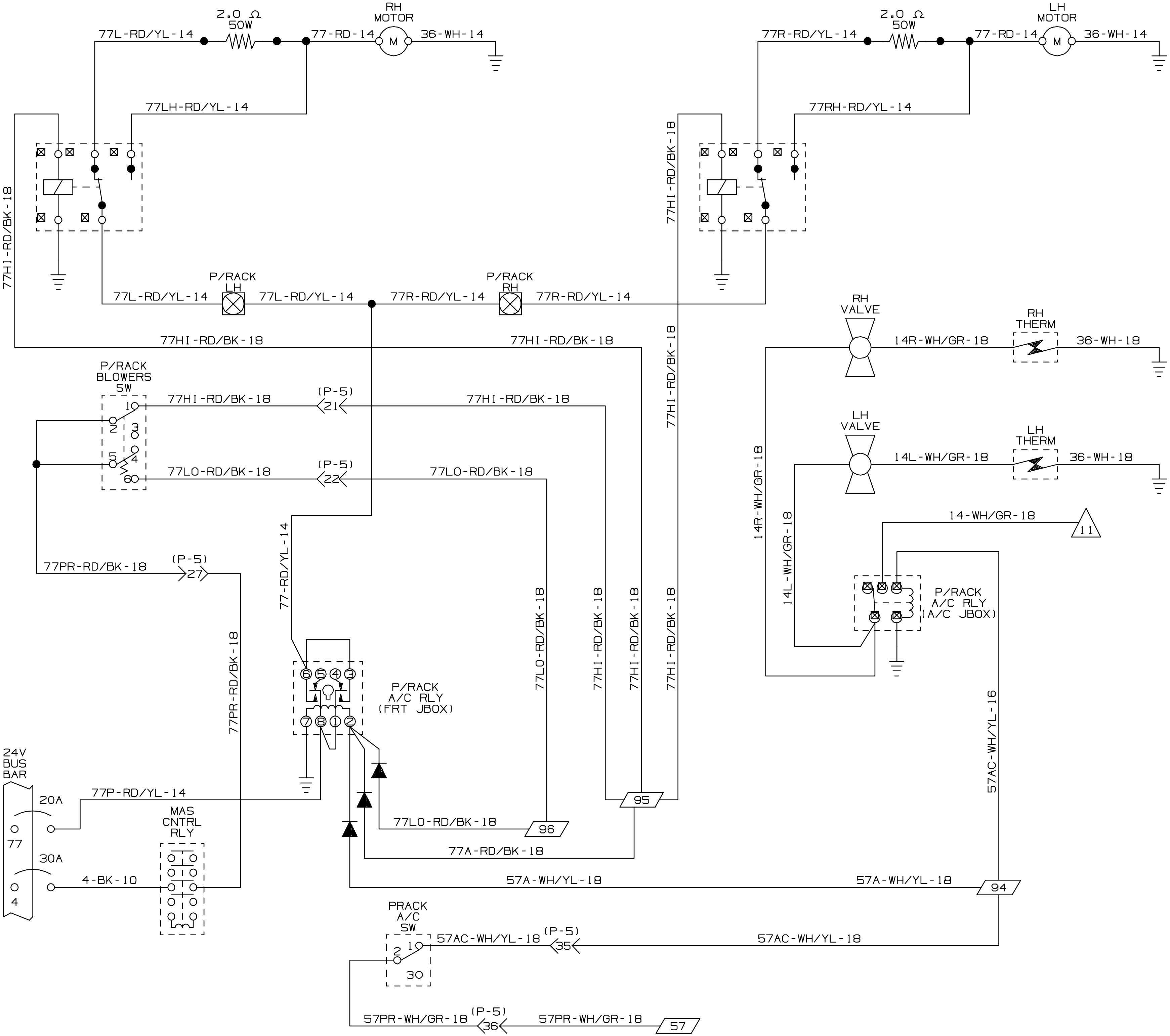
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

PARCEL RACK AC POWER SOURCE
102D3 & 102DL3
7L–13–1771 (REV A)


2.0 Ω
50W
RH
MOTOR
M
77L-RD/YL-14
77-RD-14
36-WH-14
77LH-RD/YL-14
2.0 Ω
50W
LH
MOTOR
M
77R-RD/YL-14
77-RD-14
36-WH-14
77RH-RD/YL-14
77HI-RD/BK-18
P/RACK
LH
77L-RD/YL-14
77L-RD/YL-14
P/RACK
RH
77R-RD/YL-14
77R-RD/YL-14
77HI-RD/BK-18
77HI-RD/BK-18
RH
VALVE
14R-WH/GR-18
RH
THERM
36-WH-18
LH
VALVE
14L-WH/GR-18
LH
THERM
36-WH-18
14R-WH/GR-18
14L-WH/GR-18
14-WH/GR-18
11
P/RACK
A/C RLY
(A/C JBOX)
57AC-WH/YL-16
P/RACK
BLOWERS
SW
1
2
3
4
5
6
77HI-RD/BK-18
(P-5)
21
77HI-RD/BK-18
77LO-RD/BK-18
(P-5)
22
77LO-RD/BK-18
77PR-RD/BK-18
(P-5)
27
77PR-RD/BK-18
77-RD/YL-14
6 5 4 3
7 8 1 2
P/RACK
A/C RLY
(FRT JBOX)
77LO-RD/BK-18
77HI-RD/BK-18
77HI-RD/BK-18
77HI-RD/BK-18
95
96
77LO-RD/BK-18
77A-RD/BK-18
24V
BUS
BAR
20A
77
30A
4
77P-RD/YL-14
MAS
CNTRL
RLY
4-BK-10
57A-WH/YL-18
57A-WH/YL-18
94
PRACK
A/C
SW
1
2
30
57AC-WH/YL-18
(P-5)
35
57AC-WH/YL-18
57PR-WH/GR-18
(P-5)
36
57PR-WH/GR-18
57

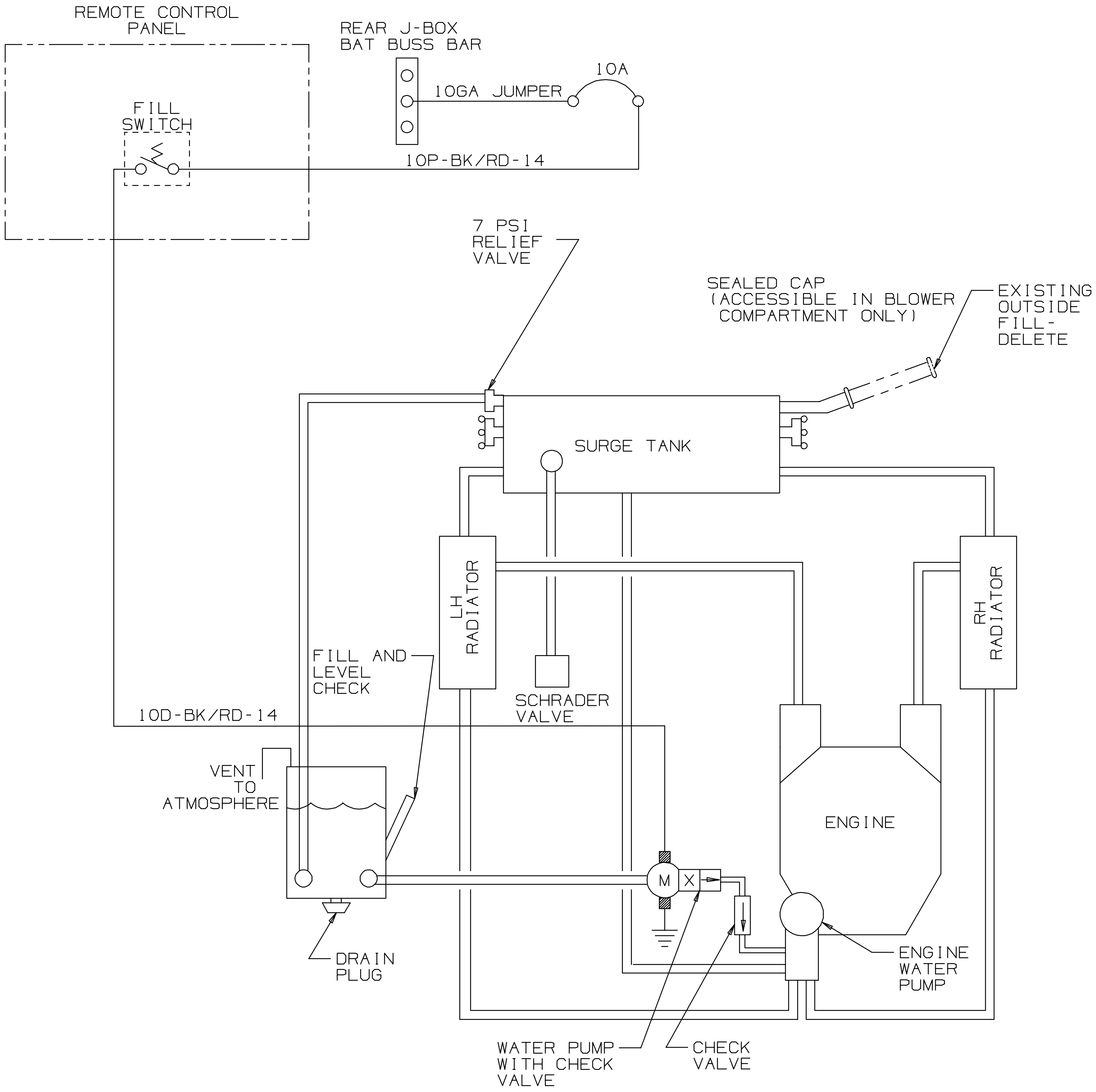
PART NO.	DESCRIPTION	REV.
7L-13-253	COOLANT RECOVERY SYSTEM (MANUAL)	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

COOLANT RECOVERY SYSTEM – MANU
102D3 & 102DL3
7L–13–253 (REV A)


REMOTE CONTROL PANEL
REAR J-BOX BAT BUSS BAR
FILL SWITCH
10GA JUMPER
10A
10P-BK/RD-14
7 PSI RELIEF VALVE
SEALED CAP (ACCESSIBLE IN BLOWER COMPARTMENT ONLY)
EXISTING OUTSIDE FILL-DELETE
SURGE TANK
LH RADIATOR
RH RADIATOR
FILL AND LEVEL CHECK
SCHRADER VALVE
10D-BK/RD-14
VENT TO ATMOSPHERE
ENGINE
M
X
DRAIN PLUG
ENGINE WATER PUMP
WATER PUMP WITH CHECK VALVE
CHECK VALVE

PART NO.	DESCRIPTION	REV.
7L-13-83	**RADIO 12V POWER SOURCE**	**B**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	◺	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

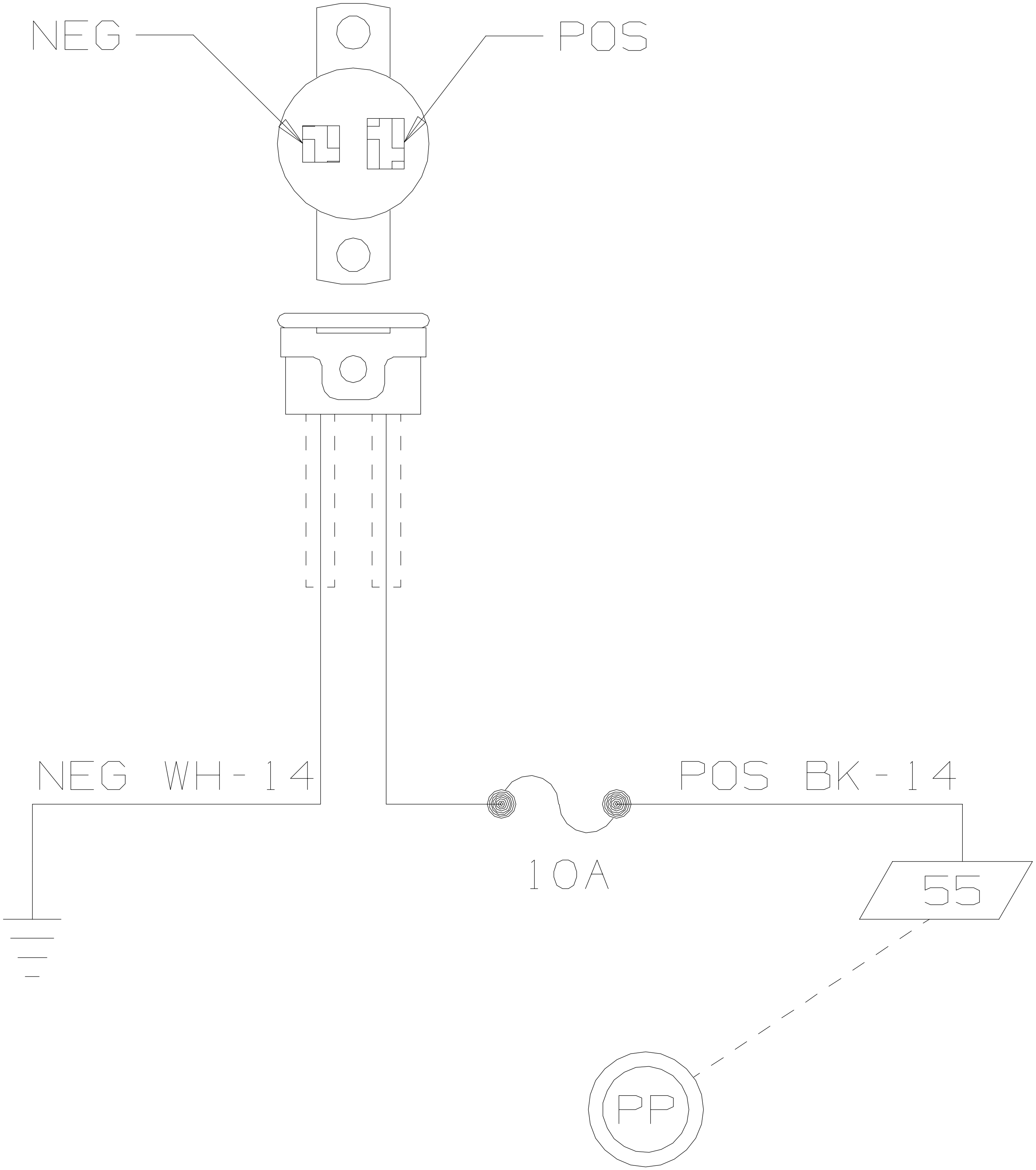
RD–RED
BR–BROWN
BK–BLACK

LEGEND

RADIO 12 VOLT POWER SOURCE

ALL MODELS

7L-13-83 (REV B)


NEG
POS
NEG WH-14
POS BK-14
10A
55
PP

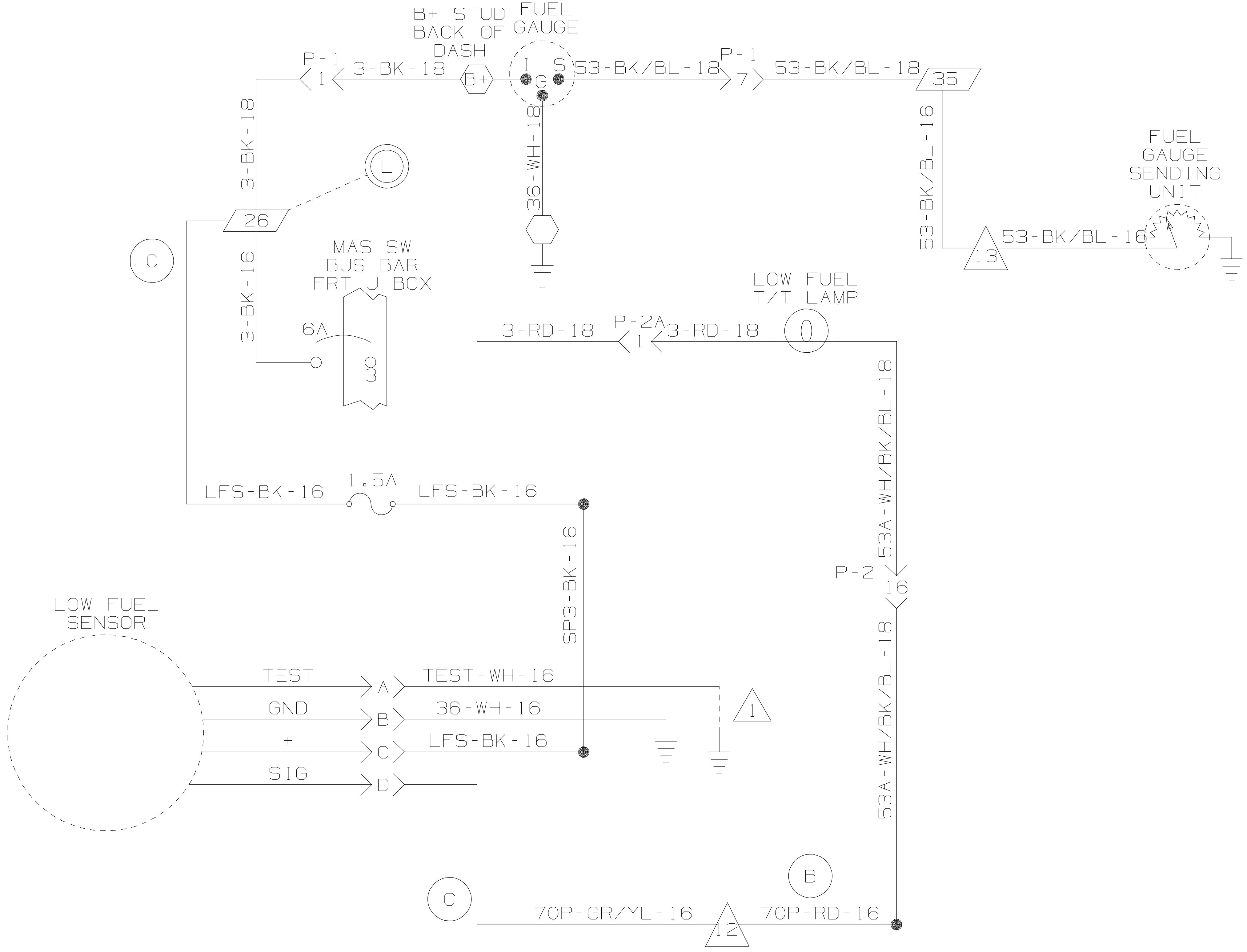
PART NO.	DESCRIPTION	REV.
7L-13-70	**FUEL GAUGE**	**C**

▱	FRT J—BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J—BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J—BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J—BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J—BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J—BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J—BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J—BOX VERT STUD BLK	— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE
GR—GREEN
YL—YELLOW
OR—ORANGE
RD—RED
BR—BROWN
BK—BLACK

LEGEND

FUEL GAUGE (W/ SENSOR)
102D3 & 102DL3
7L-13-70 (REV C)


B+ STUD BACK OF DASH
FUEL GAUGE
P-1
1
3-BK-18
B+
I
S
G
53-BK/BL-18
P-1
7
53-BK/BL-18
35
3-BK-18
L
26
C
3-BK-16
MAS SW BUS BAR FRT J BOX
6A
3
3-BK-16
36-WH-18
53-BK/BL-16
FUEL GAUGE SENDING UNIT
13
53-BK/BL-16
LOW FUEL T/T LAMP
3-RD-18
P-2A
1
3-RD-18
0
53A-WH/BK/BL-18
P-2
16
53A-WH/BK/BL-18
LFS-BK-16
1.5A
LFS-BK-16
SP3-BK-16
LOW FUEL SENSOR
TEST
A
TEST-WH-16
1
GND
B
36-WH-16
+
C
LFS-BK-16
SIG
D
C
B
70P-GR/YL-16
12
70P-RD-16

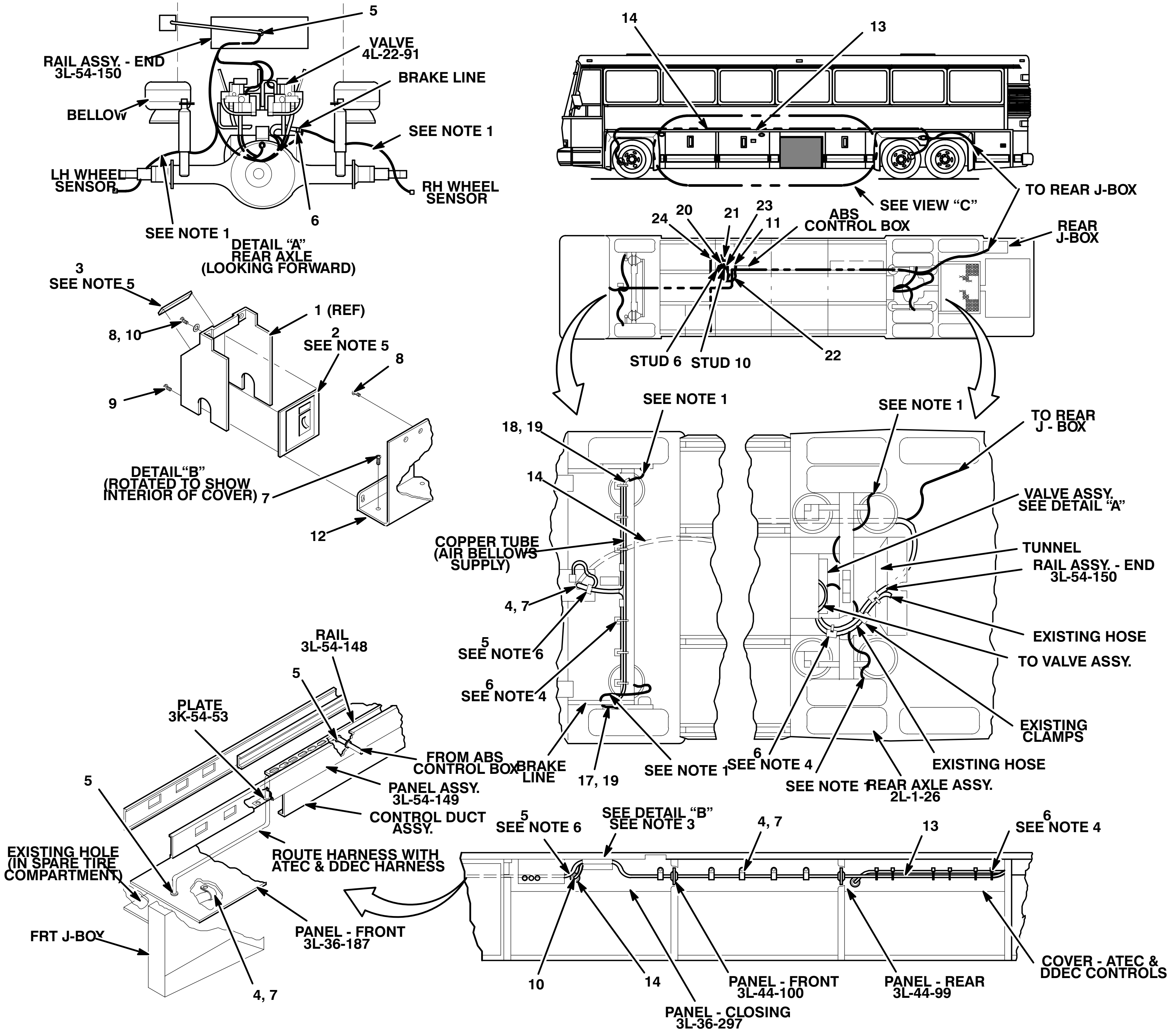
PART NO.	DESCRIPTION	REV.
7L-13-773	ANTILOCK BRAKE SYSTEM	C

ITEM	DESCRIPTION
1	COVER, BENDIX ABS UNIT
2	DECAL, ABS
3	DECAL
4	CLAMP
5	GROMMET
6	TYRAP
7	SCREW
8	SCREW
9	SCREW
10	WASHER
11	WIRE HARNESS - RELAY, ECU
12	BRACKET ASSY. - ABS
13	WIRE HARNESS - BRAKE, ABS, REAR
14	WIRE HARNESS - BRAKE, ABS, FRONT
15	WIRE HARNESS - POWER, ABS
16	SCHEMATIC - ABS
17	WIRE HARNESS - SENSOR, RF
18	WIRE HARNESS - SENSOR, LF
19	LOCK BUSHING
20	JUMPER
21	RELAY
22	JUMPER - RELAY, ABS
23	JUMPER - RELAY, ABS
24	WIRE LEAD - RELAY, ABS

NOTES:

1 SENSOR LEADS FOLLOW BRAKE HOSE, USING ITEM 6. ATTACH WHERE NECESSARY TO KEEP FROM BECOMING DAMAGED.
2 ROUTE HARNESS THROUGH EXISTING SQUARE TUBE.
3 LOCATE ITEM 12 21.00 INCHES FROM PANEL - FRONT (3L-44-100) AND MOUNT TO THE OUTSIDE OF TUNNEL ASSY. USING ITEMS 8 & 12. COVER WITH ITEM 1 USING ITEMS 8 & 10. APPLY DECALS, ITEMS 2 & 3, PER NOTE 5 BEFORE INSTALLING COVER.
4 LOCATE ITEM 6 APPROXIMATELY AS SHOWN.
5 CENTER ITEMS 2 & 3 AS SHOWN.
6 DISCARD PLUGS USED IN HOLES WHEN ROUTING HARNESS.

ANTILOCK BRAKE SYSTEM
102A3/B3/C3/DL3 MODELS ONLY
7L-13-773 (REV C)


5
RAIL ASSY. - END
3L-54-150
VALVE
4L-22-91
BRAKE LINE
BELLOW
SEE NOTE 1
LH WHEEL
SENSOR
RH WHEEL
SENSOR
SEE NOTE 1
6
DETAIL "A"
REAR AXLE
(LOOKING FORWARD)
14
13
TO REAR J-BOX
SEE VIEW "C"
24
20
21
23
11
ABS
CONTROL BOX
REAR
J-BOX
STUD 6
STUD 10
22
3
SEE NOTE 5
1 (REF)
8, 10
2
SEE NOTE 5
8
9
DETAIL"B"
(ROTATED TO SHOW
INTERIOR OF COVER)
7
12
SEE NOTE 1
SEE NOTE 1
18, 19
TO REAR
J - BOX
14
VALVE ASSY.
SEE DETAIL "A"
COPPER TUBE
(AIR BELLOWS
SUPPLY)
TUNNEL
RAIL ASSY. - END
3L-54-150
4, 7
EXISTING HOSE
5
SEE NOTE 6
TO VALVE ASSY.
6
SEE NOTE 4
EXISTING
CLAMPS
BRAKE
LINE
17, 19
SEE NOTE 1
6
SEE NOTE 4
EXISTING HOSE
SEE NOTE 1
REAR AXLE ASSY.
2L-1-26
RAIL
3L-54-148
5
PLATE
3K-54-53
FROM ABS
CONTROL BOX
PANEL ASSY.
3L-54-149
5
CONTROL DUCT
ASSY.
ROUTE HARNESS WITH
ATEC & DDEC HARNESS
EXISTING HOLE
(IN SPARE TIRE
COMPARTMENT)
PANEL - FRONT
3L-36-187
FRT J-BOX
4, 7
5
SEE NOTE 6
SEE DETAIL "B"
SEE NOTE 3
4, 7
13
6
SEE NOTE 4
10
14
PANEL - CLOSING
3L-36-297
PANEL - FRONT
3L-44-100
PANEL - REAR
3L-44-99
COVER - ATEC &
DDEC CONTROLS

PART NO.	DESCRIPTION	REV.
7L-13-993	PARCEL RACK SPEAKERS	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

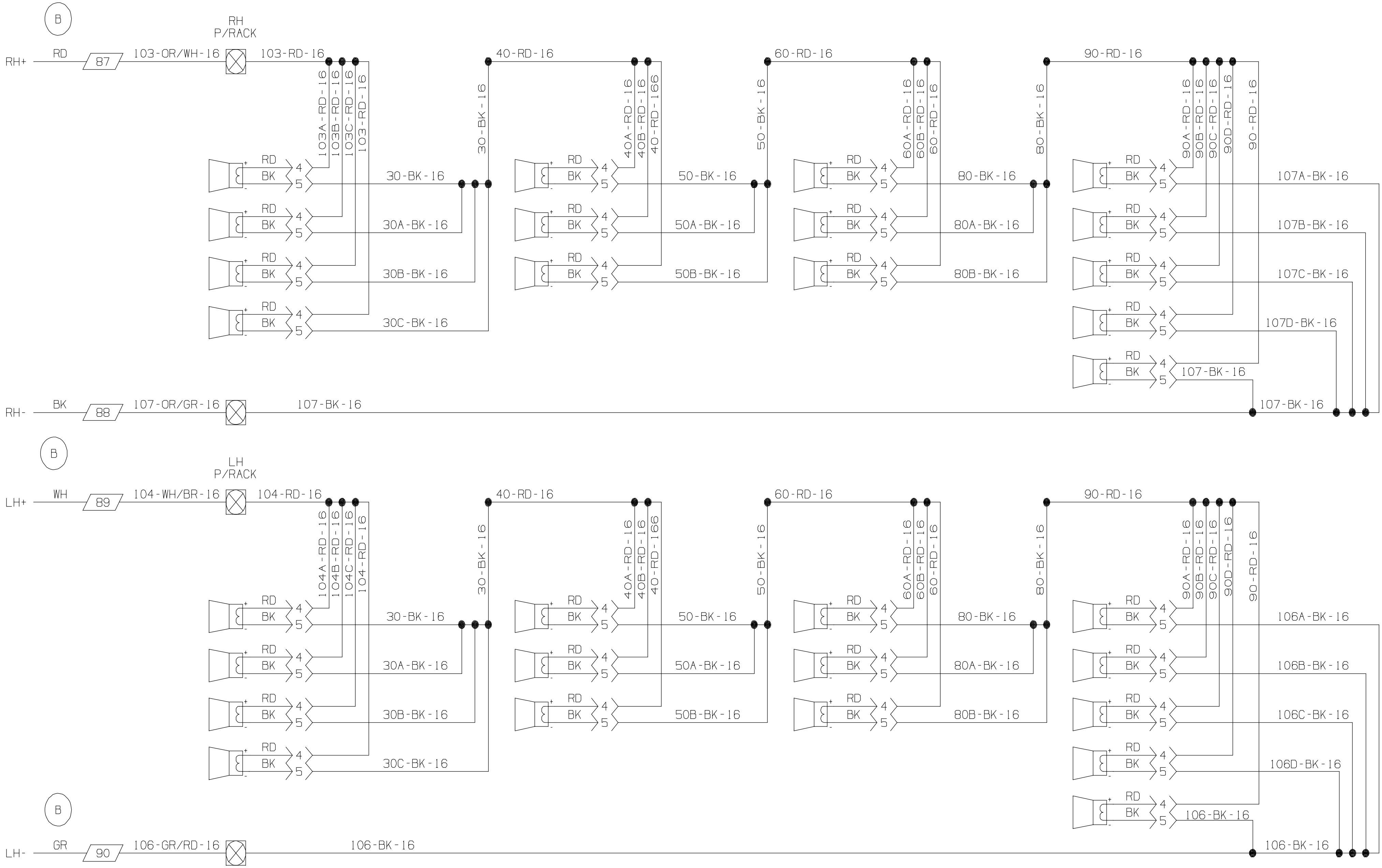
RD–RED
BR–BROWN
BK–BLACK

LEGEND

PARCEL RACK SPEAKERS

102D & 102DL3

7L-13-993 (REV B)


B
RH
P/RACK
RH+
RD
87
103-OR/WH-16
103-RD-16
103A-RD-16
103B-RD-16
103C-RD-16
103-RD-16
30-BK-16
40-RD-16
40A-RD-16
40B-RD-16
40-RD-166
50-BK-16
60-RD-16
60A-RD-16
60B-RD-16
60-RD-16
80-BK-16
90-RD-16
90A-RD-16
90B-RD-16
90C-RD-16
90D-RD-16
90-RD-16
RD
BK
4
5
30-BK-16
30A-BK-16
30B-BK-16
30C-BK-16
50-BK-16
50A-BK-16
50B-BK-16
80-BK-16
80A-BK-16
80B-BK-16
107A-BK-16
107B-BK-16
107C-BK-16
107D-BK-16
107-BK-16
RH-
BK
88
107-OR/GR-16
107-BK-16
107-BK-16
B
LH
P/RACK
LH+
WH
89
104-WH/BR-16
104-RD-16
104A-RD-16
104B-RD-16
104C-RD-16
104-RD-16
30-BK-16
40-RD-16
40A-RD-16
40B-RD-16
40-RD-166
50-BK-16
60-RD-16
60A-RD-16
60B-RD-16
60-RD-16
80-BK-16
90-RD-16
90A-RD-16
90B-RD-16
90C-RD-16
90D-RD-16
90-RD-16
30-BK-16
30A-BK-16
30B-BK-16
30C-BK-16
50-BK-16
50A-BK-16
50B-BK-16
80-BK-16
80A-BK-16
80B-BK-16
106A-BK-16
106B-BK-16
106C-BK-16
106D-BK-16
106-BK-16
B
LH-
GR
90
106-GR/RD-16
106-BK-16
106-BK-16

PART NO.	DESCRIPTION	REV.
7L-13-1771	PARCEL RACK AC POWER SOURCE	A

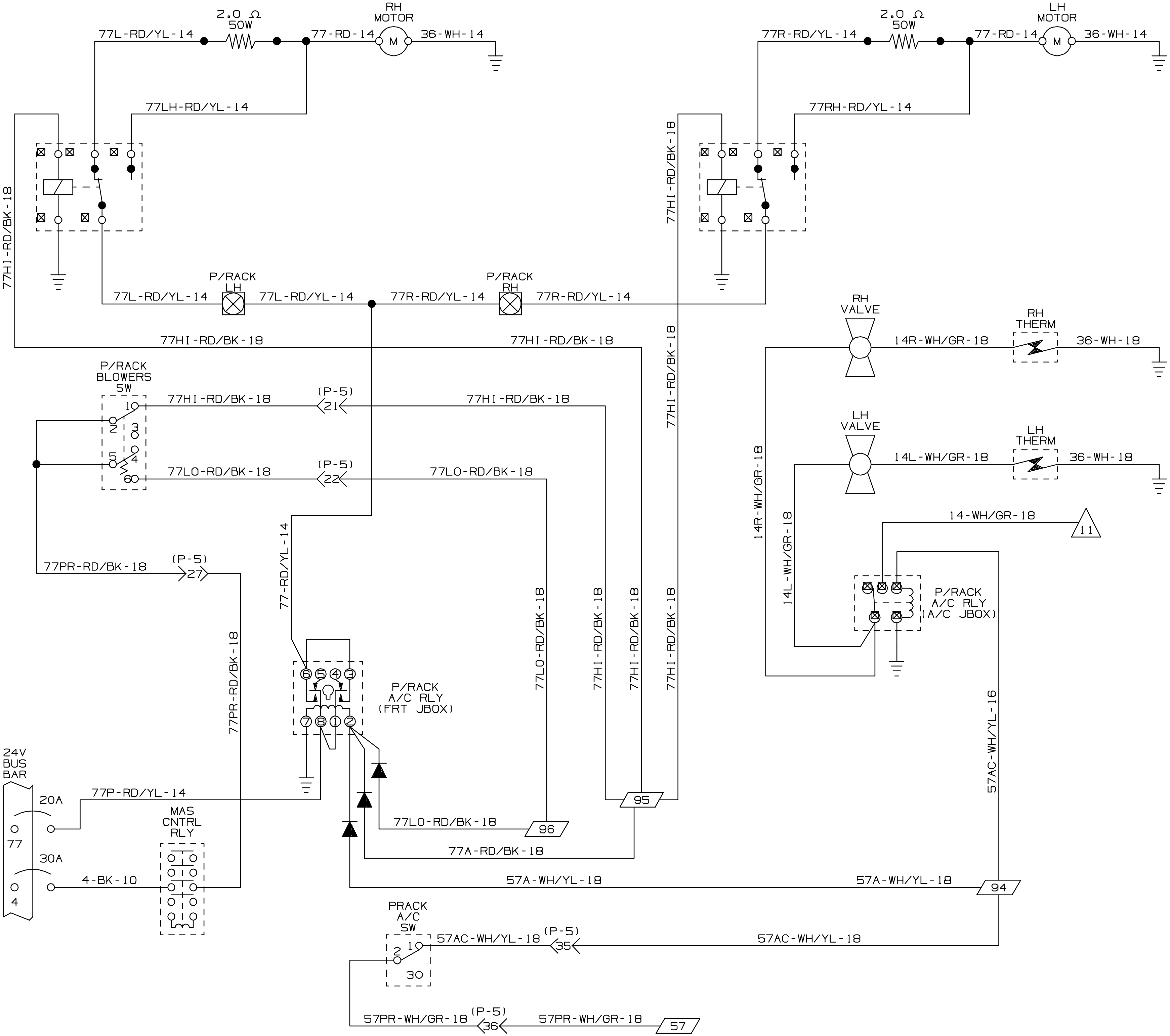
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

PARCEL RACK AC POWER SOURCE
102D3 & 102DL3
7L–13–1771 (REV A)



2.0 Ω
50W
RH
MOTOR
M
77L-RD/YL-14
77-RD-14
36-WH-14
77LH-RD/YL-14
2.0 Ω
50W
LH
MOTOR
M
77R-RD/YL-14
77-RD-14
36-WH-14
77RH-RD/YL-14
77HI-RD/BK-18
77HI-RD/BK-18
P/RACK
LH
P/RACK
RH
77L-RD/YL-14
77L-RD/YL-14
77R-RD/YL-14
77R-RD/YL-14
77HI-RD/BK-18
77HI-RD/BK-18
77HI-RD/BK-18
RH
VALVE
RH
THERM
14R-WH/GR-18
36-WH-18
P/RACK
BLOWERS
SW
1
2
3
4
5
6
77HI-RD/BK-18
(P-5)
21
77HI-RD/BK-18
77LO-RD/BK-18
(P-5)
22
77LO-RD/BK-18
LH
VALVE
LH
THERM
14L-WH/GR-18
36-WH-18
14R-WH/GR-18
14L-WH/GR-18
14-WH/GR-18
11
77-RD/YL-14
77PR-RD/BK-18
(P-5)
27
77PR-RD/BK-18
77LO-RD/BK-18
77HI-RD/BK-18
77HI-RD/BK-18
77HI-RD/BK-18
P/RACK
A/C RLY
(A/C JBOX)
57AC-WH/YL-16
6
5
4
3
7
8
1
2
P/RACK
A/C RLY
(FRT JBOX)
24V
BUS
BAR
20A
77
30A
4
77P-RD/YL-14
MAS
CNTRL
RLY
4-BK-10
95
77LO-RD/BK-18
96
77A-RD/BK-18
57A-WH/YL-18
57A-WH/YL-18
94
PRACK
A/C
SW
1
2
30
57AC-WH/YL-18
(P-5)
35
57AC-WH/YL-18
57PR-WH/GR-18
(P-5)
36
57PR-WH/GR-18
57

PART NO.	DESCRIPTION	REV.
7L-13-1166	INTERIOR COACH LIGHTING	D

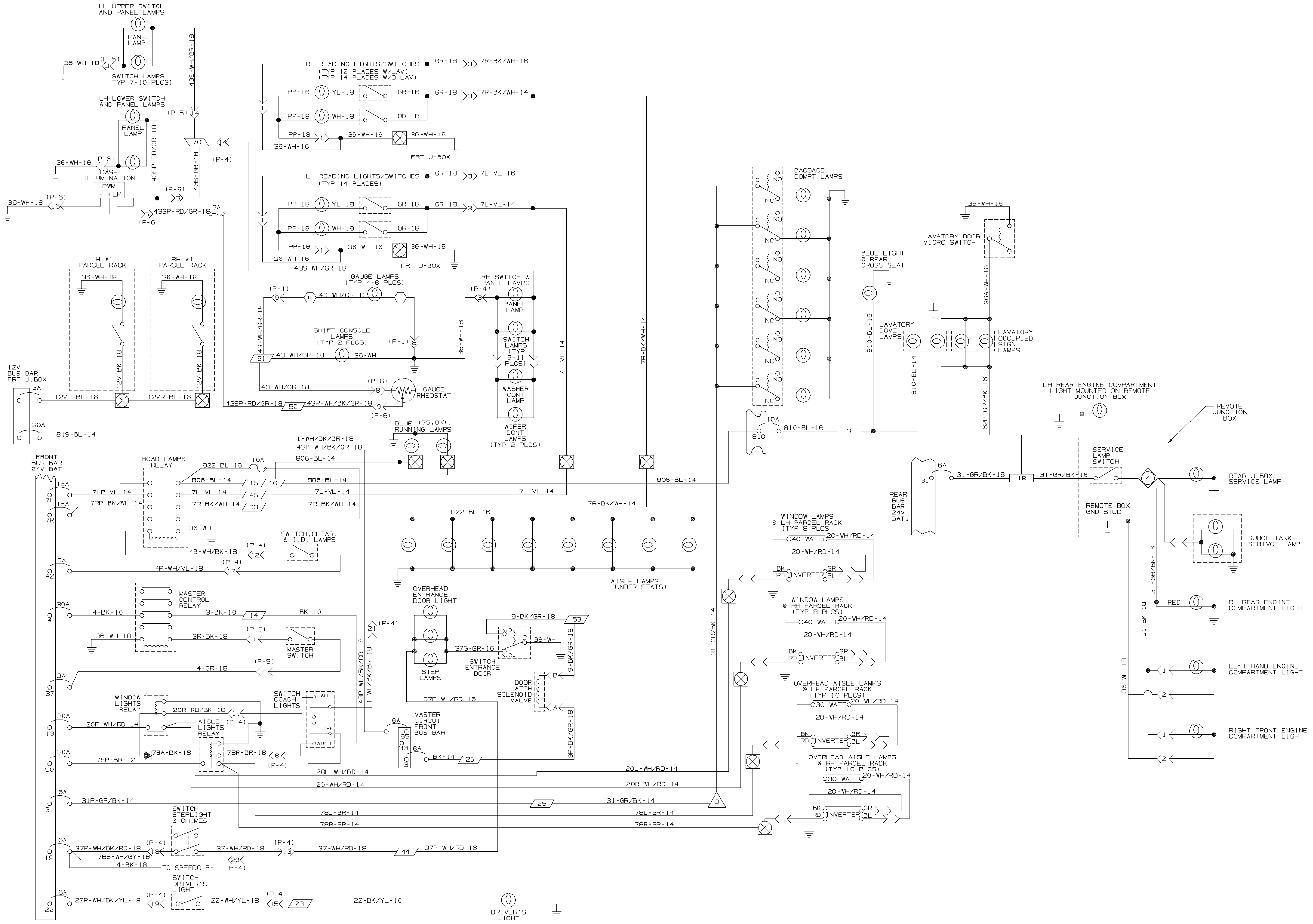
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

INTERIOR COACH LIGHTING
102D3 & 102DL3 MODELS
7L-13-1166 (REV. D)


LH UPPER SWITCH AND PANEL LAMPS
PANEL LAMP
SWITCH LAMPS (TYP 7-10 PLCS)
36-WH-18
(P-5)
43S-WH/GR-18
LH LOWER SWITCH AND PANEL LAMPS
PANEL LAMP
43SP-RD/GR-18
DASH ILLUMINATION
PWM
- + LP
(P-6)
43S-GR-18
70
(P-4)
43SP-RD/GR-18
3A
RH READING LIGHTS/SWITCHES (TYP 12 PLACES W/LAV) (TYP 14 PLACES W/O LAV)
GR-18
7R-BK/WH-16
PP-18
YL-18
GR-18
7R-BK/WH-14
WH-18
OR-18
36-WH-16
FRT J-BOX
LH READING LIGHTS/SWITCHES (TYP 14 PLACES)
7L-VL-16
7L-VL-14
43S-WH/GR-18
LH #1 PARCEL RACK
RH #1 PARCEL RACK
12V-BK-18
12V BUS BAR FRT J.BOX
12VL-BL-16
12VR-BL-16
30A
819-BL-14
GAUGE LAMPS (TYP 4-6 PLCS)
(P-1)
43-WH/GR-18
SHIFT CONSOLE LAMPS (TYP 2 PLCS)
36-WH
61
52
43P-WH/BK/GR-18
GAUGE RHEOSTAT
BLUE (75.0Ω) RUNNING LAMPS
1-WH/BK/BR-18
RH SWITCH & PANEL LAMPS
PANEL LAMP
SWITCH LAMPS (TYP 5-11 PLCS)
WASHER CONT LAMP
WIPER CONT LAMPS (TYP 2 PLCS)
36-WH-18
7R-BK/WH-14
FRONT BUS BAR 24V BAT
ROAD LAMPS RELAY
822-BL-16
10A
806-BL-14
15 16
45
33
7LP-VL-14
7RP-BK/WH-14
7L
7R
15A
SWITCH,CLEAR, & I.D. LAMPS
4B-WH/BK-18
4P-WH/VL-18
42
AISLE LAMPS (UNDER SEATS)
MASTER CONTROL RELAY
4-BK-10
3-BK-10
14
BK-10
3R-BK-18
MASTER SWITCH
4-GR-18
37
WINDOW LIGHTS RELAY
20R-RD/BK-18
20P-WH/RD-14
13
AISLE LIGHTS RELAY
78A-BK-18
78B-BR-18
78P-BR-12
50
SWITCH COACH LIGHTS
ALL
OFF
AISLE
MASTER CIRCUIT FRONT BUS BAR
6A
65
33
BK-14
26
21
OVERHEAD ENTRANCE DOOR LIGHT
STEP LAMPS
37G-GR-16
SWITCH ENTRANCE DOOR
N.O.
N.C.
9-BK/GR-18
53
DOOR LATCH SOLENOID VALVE
9P-BK/GR-18
37P-WH/RD-16
20L-WH/RD-14
20-WH/RD-14
20R-WH/RD-14
31P-GR/BK-14
25
31-GR/BK-14
78L-BR-14
78R-BR-14
SWITCH STEPLIGHT & CHIMES
37P-WH/BK/RD-18
78S-WH/GY-18
4-BK-18
TO SPEEDO B+
37-WH/RD-18
44
19
SWITCH DRIVER'S LIGHT
22P-WH/BK/YL-18
22-WH/YL-18
23
22-BK/YL-16
DRIVER'S LIGHT
22
BAGGAGE COMPT LAMPS
C
NO
NC
810
810-BL-16
3
BLUE LIGHT @ REAR CROSS SEAT
LAVATORY DOOR MICRO SWITCH
36-WH-16
36A-WH-16
LAVATORY DOME LAMPS
LAVATORY OCCUPIED SIGN LAMPS
810-BL-14
62P-GR/BK-16
LH REAR ENGINE COMPARTMENT LIGHT MOUNTED ON REMOTE JUNCTION BOX
REMOTE JUNCTION BOX
REAR BUS BAR 24V BAT.
31
31-GR/BK-16
18
SERVICE LAMP SWITCH
REAR J-BOX SERVICE LAMP
REMOTE BOX GND STUD
SURGE TANK SERIVCE LAMP
WINDOW LAMPS @ LH PARCEL RACK (TYP 8 PLCS)
40 WATT
20-WH/RD-14
BK RD NVERTER GR BL
WINDOW LAMPS @ RH PARCEL RACK (TYP 8 PLCS)
OVERHEAD AISLE LAMPS @ LH PARCEL RACK (TYP 10 PLCS)
30 WATT
OVERHEAD AISLE LAMPS @ RH PARCEL RACK (TYP 10 PLCS)
31-BK-16
RED
RH REAR ENGINE COMPARTMENT LIGHT
31-BK-18
36-WH-18
LEFT HAND ENGINE COMPARTMENT LIGHT
RIGHT FRONT ENGINE COMPARTMENT LIGHT

PART NO.	DESCRIPTION	REV.
7L-13-1781	TRANSMISSION CONTROL AUTO-SHIFT 10 SPEED	D

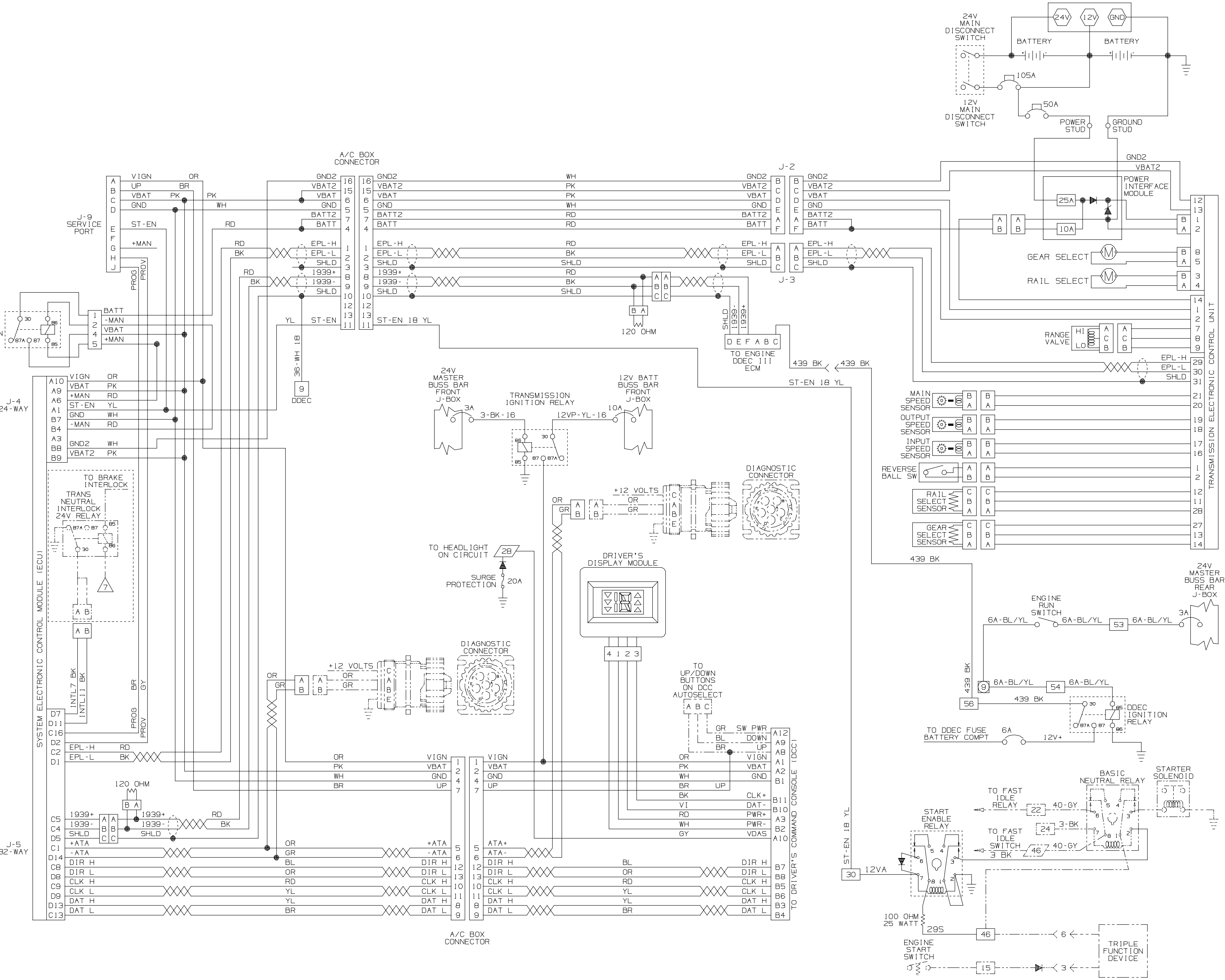
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

ELECTRONICALLY CONTROLLED TRANSMISSIO
EATON/FULLER (AUTO-SHIFT 10 SPEED)
102D3 & 102DL3 MODELS
7L-13-1781 (REV. D)


24V MAIN DISCONNECT SWITCH
12V MAIN DISCONNECT SWITCH
24V
12V
GND
BATTERY
BATTERY
105A
50A
POWER STUD
GROUND STUD
A/C BOX CONNECTOR
J-9 SERVICE PORT
VIGN
UP
VBAT
GND
ST-EN
+MAN
OR
BR
PK
WH
RD
PROG
PROV
GND2
VBAT2
BATT2
BATT
EPL-H
EPL-L
SHLD
1939+
1939-
ST-EN 18 YL
YL
36-WH 18
DDEC
J-2
J-3
120 OHM
TO ENGINE DDEC III ECM
POWER INTERFACE MODULE
25A
10A
GND2
VBAT2
GEAR SELECT
RAIL SELECT
RANGE VALVE
HI
LO
439 BK
ST-EN 18 YL
J-1
TRANSMISSION ELECTRONIC CONTROL UNIT
MAIN SPEED SENSOR
OUTPUT SPEED SENSOR
INPUT SPEED SENSOR
REVERSE BALL SW
RAIL SELECT SENSOR
GEAR SELECT SENSOR
12V PWR CONN RLY
BATT
-MAN
VBAT
+MAN
J-4 24-WAY
A10
A9
A6
A1
B7
B4
A3
B8
B9
24V MASTER BUSS BAR FRONT J-BOX
3A
3-BK-16
TRANSMISSION IGNITION RELAY
12VP-YL-16
10A
12V BATT BUSS BAR FRONT J-BOX
TO BRAKE INTERLOCK
TRANS NEUTRAL INTERLOCK 24V RELAY
INTL7 BK
INTL11 BK
SYSTEM ELECTRONIC CONTROL MODULE (ECU)
DIAGNOSTIC CONNECTOR
+12 VOLTS
TO HEADLIGHT ON CIRCUIT
28
SURGE PROTECTION
20A
DRIVER'S DISPLAY MODULE
4 1 2 3
TO UP/DOWN BUTTONS ON DCC AUTOSELECT
SW PWR
DOWN
UP
VIGN
CLK+
DAT-
PWR+
PWR-
VDAS
TO DRIVER'S COMMAND CONSOLE (DCC)
J-5 32-WAY
D7
D11
C16
D2
C2
D1
C5
C4
D5
C1
D14
C8
D8
C9
D9
D13
C13
+ATA
-ATA
DIR H
DIR L
CLK H
CLK L
DAT H
DAT L
BL
GR
GY
VI
439 BK
24V MASTER BUSS BAR REAR J-BOX
ENGINE RUN SWITCH
6A-BL/YL
53
54
56
9
DDEC IGNITION RELAY
TO DDEC FUSE BATTERY COMPT
6A
12V+
START ENABLE RELAY
TO FAST IDLE RELAY
22
40-GY
24
3-BK
TO FAST IDLE SWITCH
46
3 BK
BASIC NEUTRAL RELAY
STARTER SOLENOID
30
12VA
100 OHM 25 WATT
29S
ENGINE START SWITCH
15
TRIPLE FUNCTION DEVICE
6
3

PART NO.	DESCRIPTION	REV.
7L-13-1949	TARGET CLUSTER - RH	A

▱	FRT J—BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J—BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J—BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J—BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J—BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J—BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J—BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J—BOX VERT STUD BLK	— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE

GR—GREEN
YL—YELLOW
OR—ORANGE

RD—RED
BR—BROWN
BK—BLACK

LEGEND

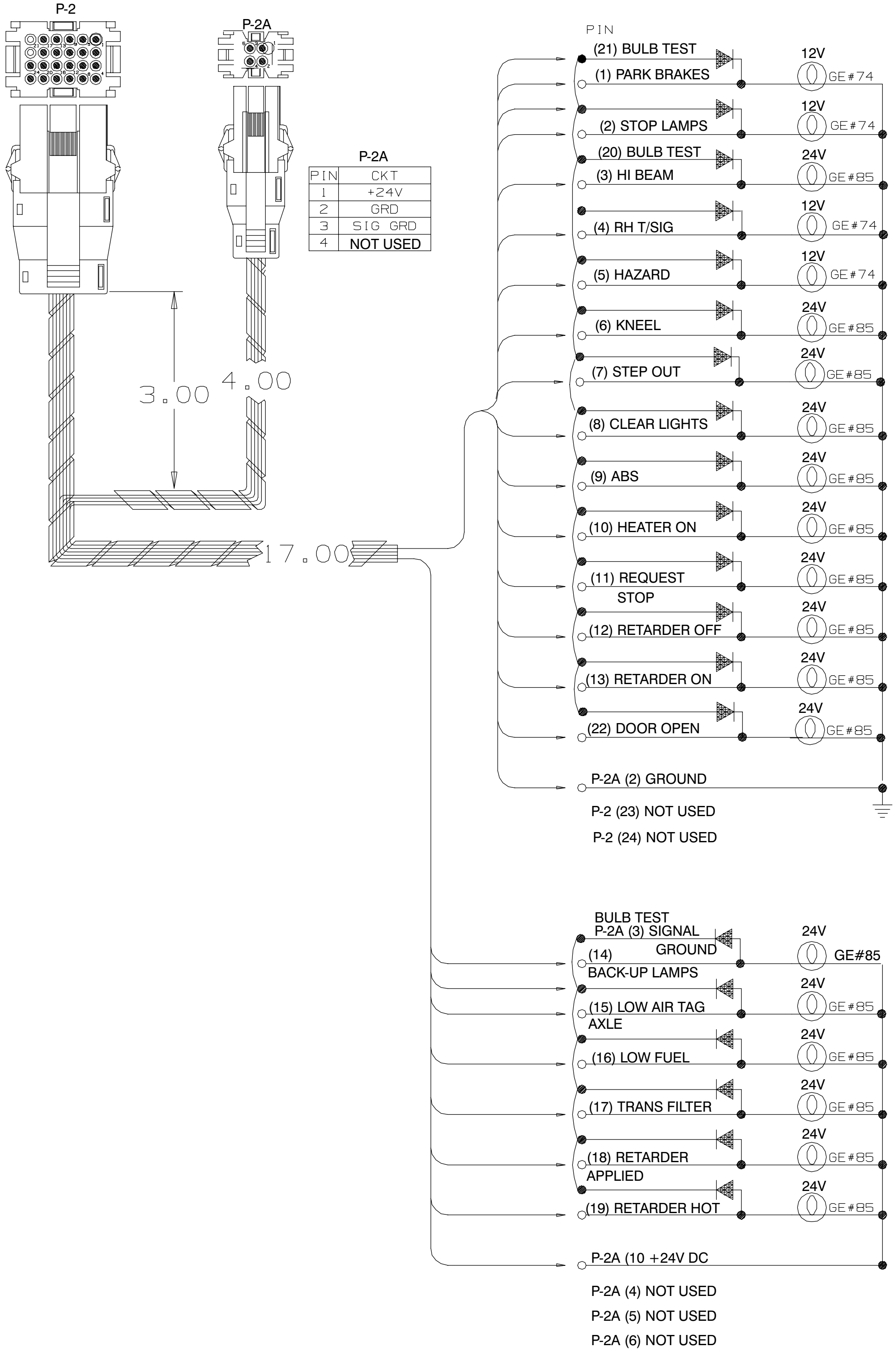
TARGET CLUSTER — RIGHT-HAND
102D3 & 102DL3 MODELS
7L-13-1949 (REV A)

P-2

PIN	CKT
1	PARK BRAKES
2	STOP LAMPS
3	HIGH BEAM
4	RH T/SIG
5	HAZARD
6	KNEEL
7	STEP OUT
8	CLEAR LIGHTS
9	ABS RF WRNG LIGHTS
10	HEATER ON
11	REQUEST STOP
12	RETARDER OFF
13	RETARDER ON
14	BACK-UP LAMPS
15	LOW AIR TAG AXLE
16	LOW FUEL
17	TRANS FILTER
18	RETARDER APPLIED
19	RETARDER HOT
20	BULB TEST
21	BULB TEST
22	DOOR OPEN
23	NOT USED
24	NOT USED

P-2A

PIN	CKT
1	+24V
2	GRD
3	SIG GRD
4	NOT USED


P-2
P-2A
3.00
4.00
17.00
PIN
(21) BULB TEST
(1) PARK BRAKES
12V
GE#74
(2) STOP LAMPS
12V
GE#74
(20) BULB TEST
(3) HI BEAM
24V
GE#85
(4) RH T/SIG
12V
GE#74
(5) HAZARD
12V
GE#74
(6) KNEEL
24V
GE#85
(7) STEP OUT
24V
GE#85
(8) CLEAR LIGHTS
24V
GE#85
(9) ABS
24V
GE#85
(10) HEATER ON
24V
GE#85
(11) REQUEST
STOP
24V
GE#85
(12) RETARDER OFF
24V
GE#85
(13) RETARDER ON
24V
GE#85
(22) DOOR OPEN
24V
GE#85
P-2A (2) GROUND
P-2 (23) NOT USED
P-2 (24) NOT USED
BULB TEST
P-2A (3) SIGNAL
GROUND
(14)
BACK-UP LAMPS
24V
GE#85
(15) LOW AIR TAG
AXLE
24V
GE#85
(16) LOW FUEL
24V
GE#85
(17) TRANS FILTER
24V
GE#85
(18) RETARDER
APPLIED
24V
GE#85
(19) RETARDER HOT
24V
GE#85
P-2A (10 +24V DC
P-2A (4) NOT USED
P-2A (5) NOT USED
P-2A (6) NOT USED

PART NO.	DESCRIPTION	REV.
7L-13-2013	**REVERSE THROTTLE INTERLOCK**	

▱	FRT J–BOX STUD BLOCK	○ IL B+	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▣	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

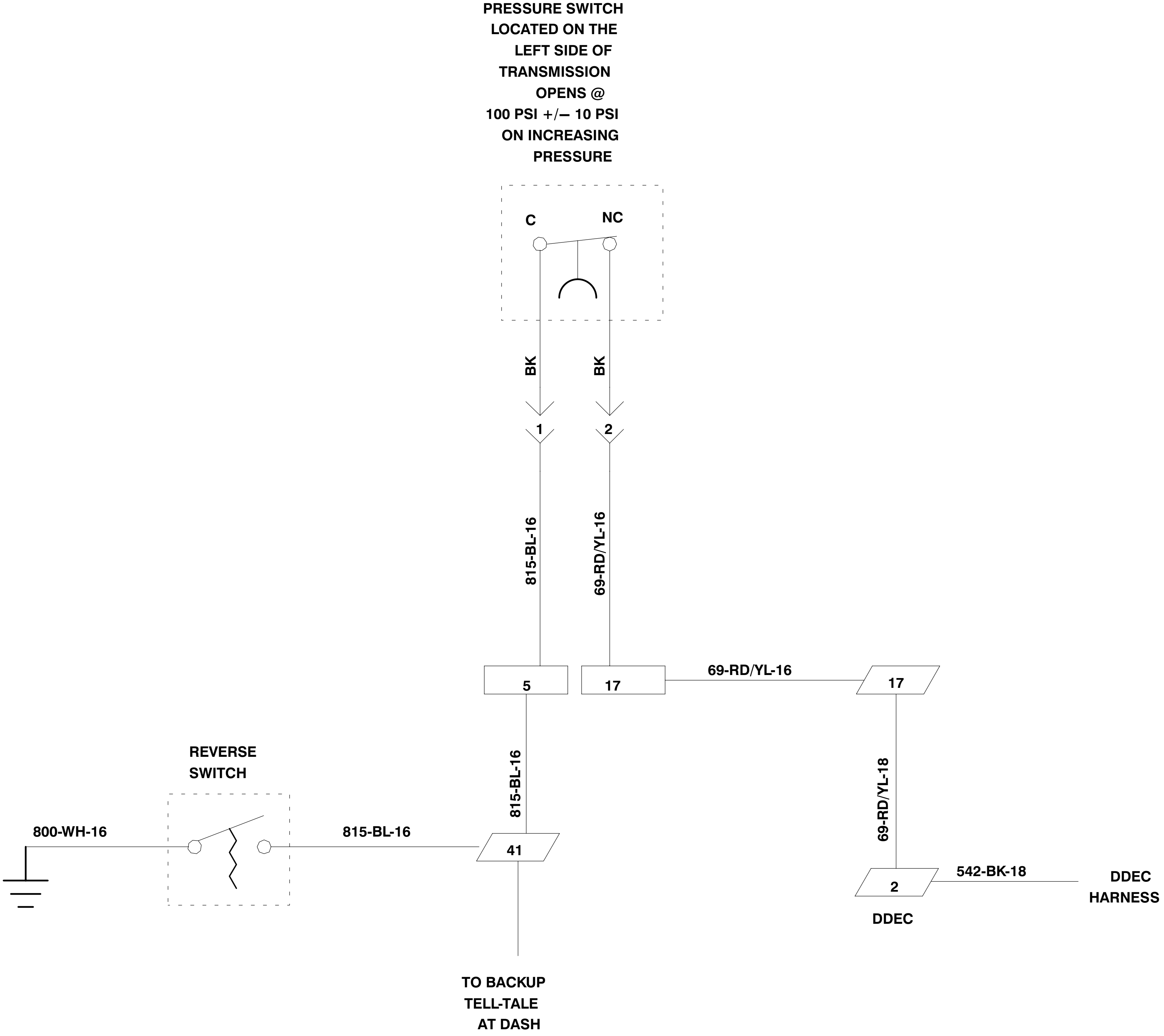
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

REVERSE THROTTLE INTERLOCK
102D3 & 102DL3 MODELS
7L-13-2013 (REV A)


PRESSURE SWITCH
LOCATED ON THE
LEFT SIDE OF
TRANSMISSION
OPENS @
100 PSI +/– 10 PSI
ON INCREASING
PRESSURE
C
NC
BK
BK
1
2
815-BL-16
69-RD/YL-16
5
17
69-RD/YL-16
17
REVERSE
SWITCH
815-BL-16
69-RD/YL-18
800-WH-16
815-BL-16
41
542-BK-18
2
DDEC
HARNESS
DDEC
TO BACKUP
TELL-TALE
AT DASH

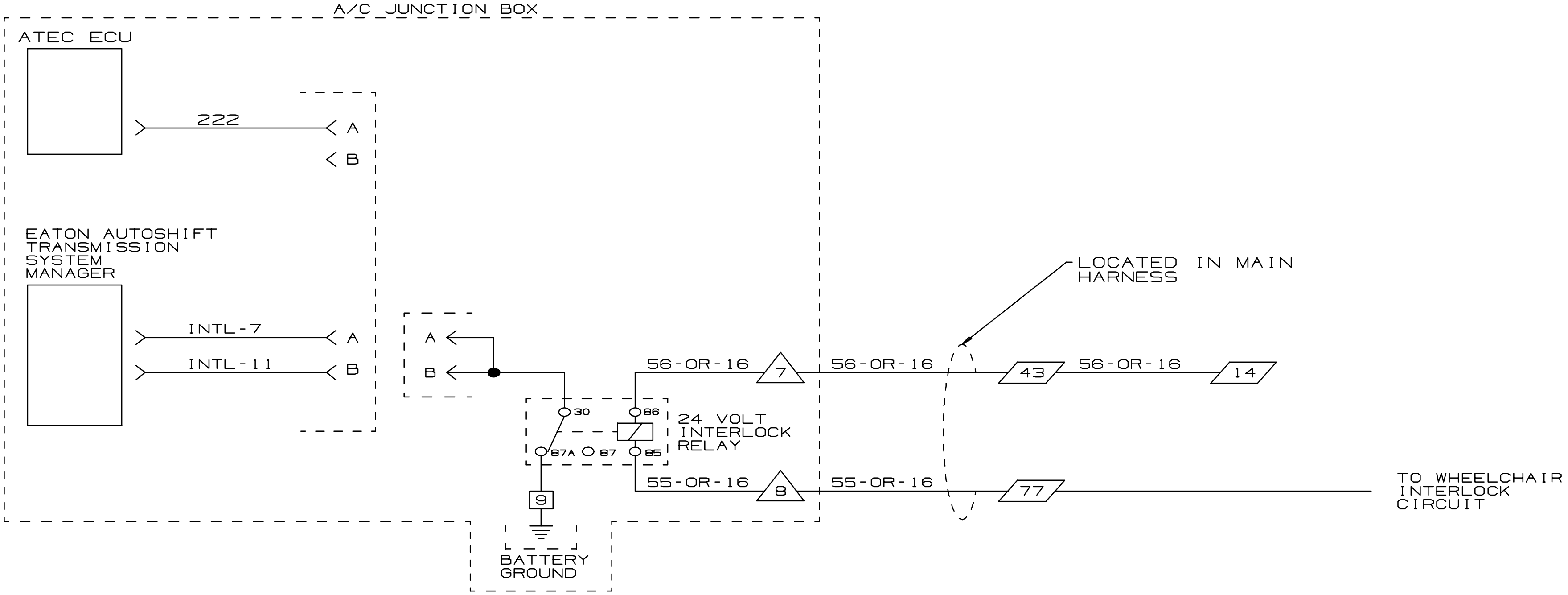
PART NO.	DESCRIPTION	REV.
7L-13-2127	NEUTRAL TRANSMISSION INTERLOCK	C

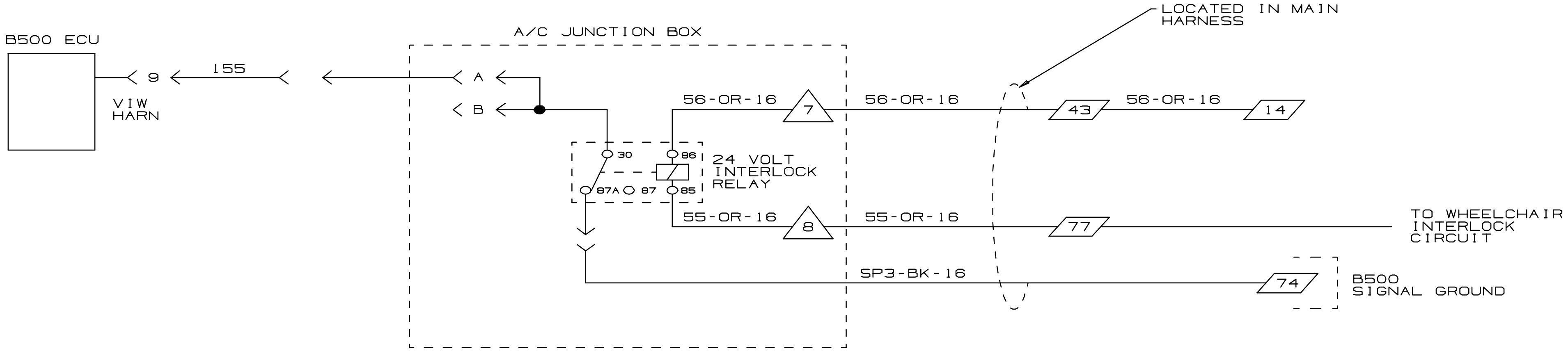
▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE	GR–GREEN	RD–RED
GY–GREY	YL–YELLOW	BR–BROWN
VO–VIOLET	OR–ORANGE	BK–BLACK
BL–BLUE		

LEGEND

NEUTRAL TRANSMISSION INTERLOCK
102D3 & 102DL3 MODELS
7L-13-2127 (REV. C)


A/C JUNCTION BOX
ATEC ECU
222
A
B
EATON AUTOSHIFT TRANSMISSION SYSTEM MANAGER
INTL-7
INTL-11
A
B
A
B
56-OR-16
7
56-OR-16
43
56-OR-16
14
30
86
24 VOLT INTERLOCK RELAY
87A
87
85
55-OR-16
8
55-OR-16
77
9
BATTERY GROUND
LOCATED IN MAIN HARNESS
TO WHEELCHAIR INTERLOCK CIRCUIT


B500 ECU
9
155
VIW HARN
A/C JUNCTION BOX
A
B
56-OR-16
7
56-OR-16
43
56-OR-16
14
30
86
24 VOLT INTERLOCK RELAY
87A
87
85
55-OR-16
8
55-OR-16
77
SP3-BK-16
74
B500 SIGNAL GROUND
LOCATED IN MAIN HARNESS
TO WHEELCHAIR INTERLOCK CIRCUIT

PART NO.	DESCRIPTION	REV.
7L-13-2252	RADIO 12V POWER SOURCE	A

▱	FRT J–BOX STUD BLOCK	(B+)	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
⌼	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

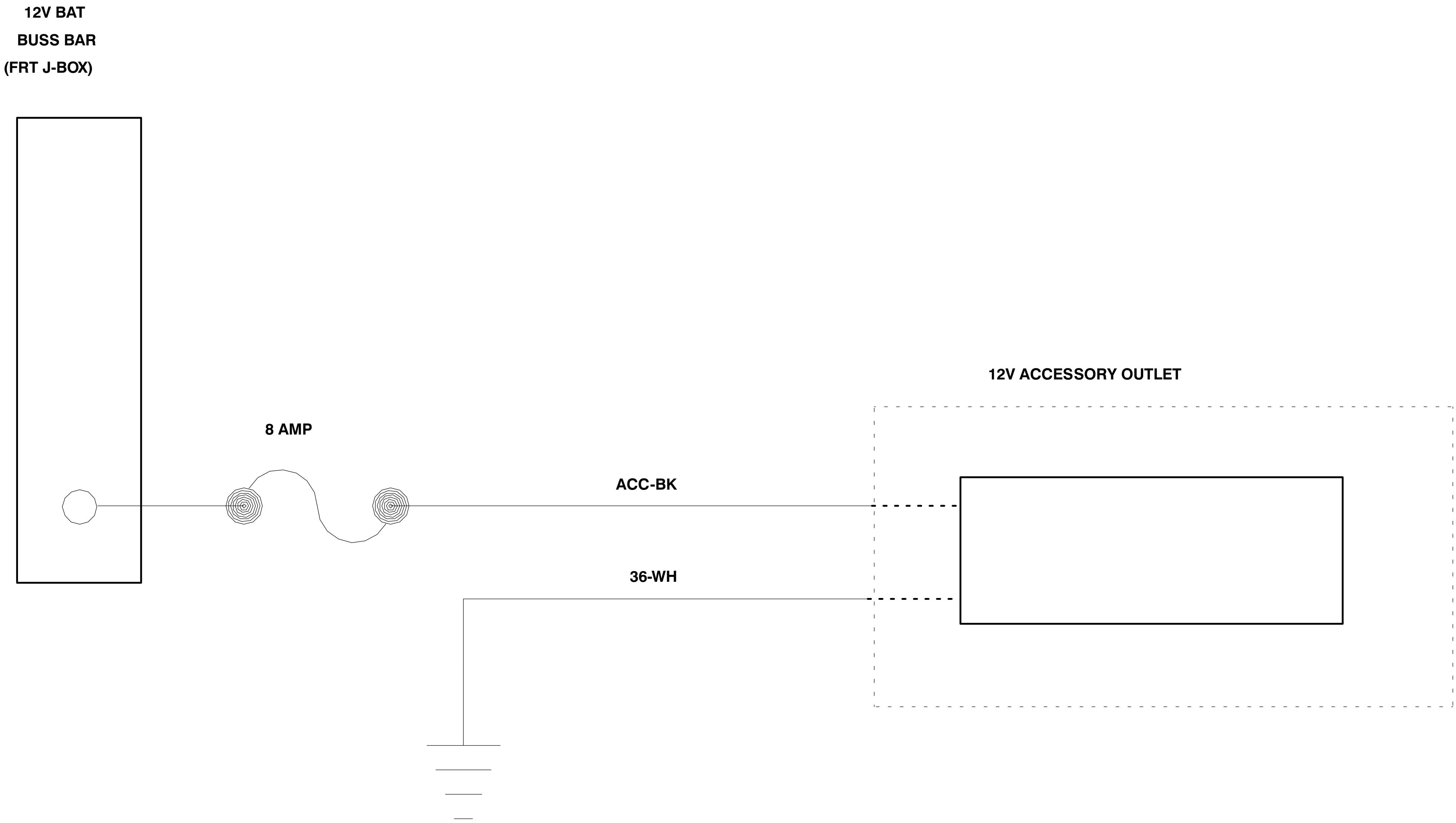
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

RADIO 12 VOLT POWER SOURCE
ALL MODELS
7L-13-2252 (REV A)


12V BAT
BUSS BAR
(FRT J-BOX)
8 AMP
ACC-BK
36-WH
12V ACCESSORY OUTLET

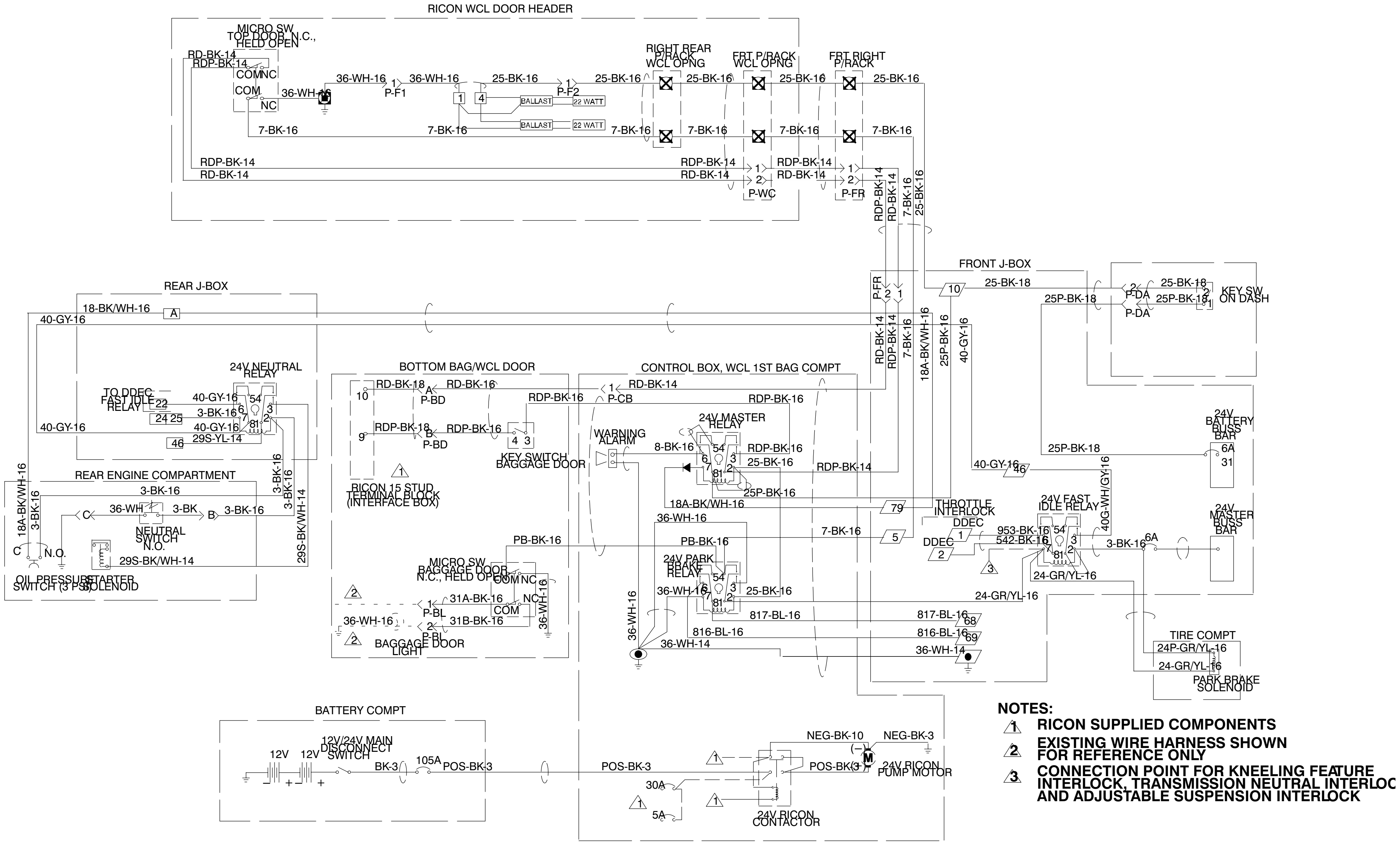
PART NO.	DESCRIPTION	REV.
7L-13-2312	RICON WHEELCHAIR LIFT INSTL.	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

RICON WHEELCHAIR COACH SCHEMATIC
MODEL 102 D SERIES
DDEC IV INSTALLATIONS
7L-13-2312 (REV A)


RICON WCL DOOR HEADER
MICRO SW TOP DOOR, N.C., HELD OPEN
RD-BK-14
RDP-BK-14
COM NC
COM
NC
36-WH-16
36-WH-16
P-F1
25-BK-16
P-F2
BALLAST
22 WATT
7-BK-16
RIGHT REAR P/RACK WCL OPNG
FRT P/RACK WCL OPNG
FRT RIGHT P/RACK
P-WC
P-FR
REAR J-BOX
18-BK/WH-16
40-GY-16
24V NEUTRAL RELAY
TO DDEC FAST IDLE RELAY
3-BK-16
29S-YL-14
REAR ENGINE COMPARTMENT
36-WH
3-BK
NEUTRAL SWITCH N.O.
C
N.O.
OIL PRESSURE SWITCH (3 PSI)
STARTER SOLENOID
29S-BK/WH-14
18A-BK/WH-16
BOTTOM BAG/WCL DOOR
RD-BK-18
RD-BK-16
P-BD
RDP-BK-18
RDP-BK-16
KEY SWITCH BAGGAGE DOOR
RICON 15 STUD TERMINAL BLOCK (INTERFACE BOX)
PB-BK-16
MICRO SW BAGGAGE DOOR N.C., HELD OPEN
31A-BK-16
31B-BK-16
P-BL
BAGGAGE DOOR LIGHT
CONTROL BOX, WCL 1ST BAG COMPT
P-CB
WARNING ALARM
8-BK-16
24V MASTER RELAY
25P-BK-16
24V PARK BRAKE RELAY
817-BL-16
816-BL-16
36-WH-14
FRONT J-BOX
25-BK-18
25P-BK-18
P-DA
KEY SW ON DASH
24V BATTERY BUSS BAR
THROTTLE INTERLOCK
DDEC
24V FAST IDLE RELAY
953-BK-16
542-BK-16
40G-WH/GY-16
24-GR/YL-16
24V MASTER BUSS BAR
TIRE COMPT
24P-GR/YL-16
PARK BRAKE SOLENOID
BATTERY COMPT
12V
12V/24V MAIN DISCONNECT SWITCH
BK-3
105A
POS-BK-3
NEG-BK-10
NEG-BK-3
24V RICON PUMP MOTOR
30A
5A
24V RICON CONTACTOR

NOTES:

1. **RICON SUPPLIED COMPONENTS**
2. **EXISTING WIRE HARNESS SHOWN FOR REFERENCE ONLY**
3. **CONNECTION POINT FOR KNEELING FEATURE INTERLOCK, TRANSMISSION NEUTRAL INTERLOC AND ADJUSTABLE SUSPENSION INTERLOCK**

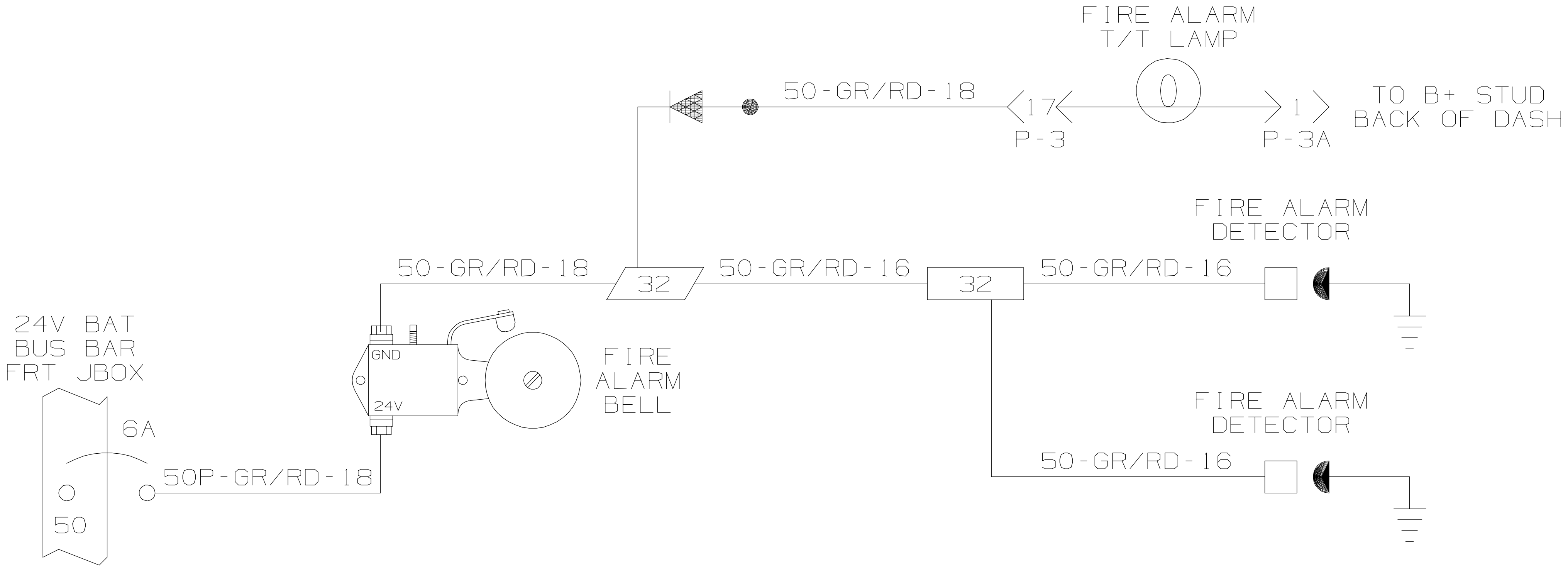
PART NO.	DESCRIPTION	REV.
7L-13-2283	**FIRE ALARM CIRCUIT**	**A**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE	GR–GREEN	RD–RED
GY–GREY	YL–YELLOW	BR–BROWN
VO–VIOLET	OR–ORANGE	BK–BLACK
BL–BLUE		

LEGEND

FIRE ALARM CIRCUIT W/BELL
102D3 & 102DL3 MODELS
7L-13-2283 (REV. A)


FIRE ALARM
T/T LAMP
50-GR/RD-18
17
P-3
1
P-3A
TO B+ STUD
BACK OF DASH
FIRE ALARM
DETECTOR
50-GR/RD-18
32
50-GR/RD-16
32
50-GR/RD-16
24V BAT
BUS BAR
FRT JBOX
GND
24V
FIRE
ALARM
BELL
6A
50P-GR/RD-18
50
FIRE ALARM
DETECTOR
50-GR/RD-16

PART NO.	DESCRIPTION	REV.
7L-13-2376	STOP REQUEST SIGN	C

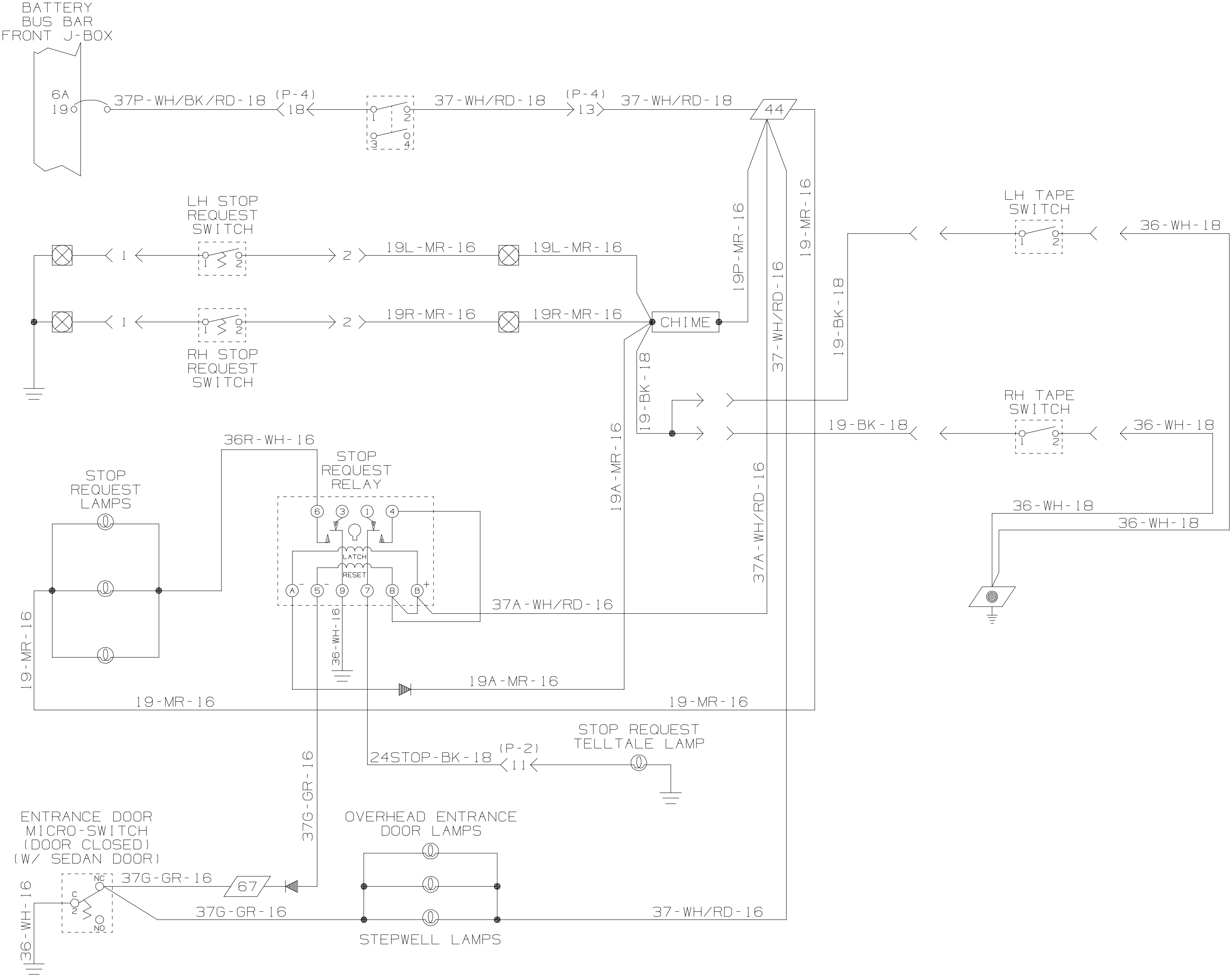
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

STOP REQUEST SIGN INSTALLATION
102D3 & 102DL3 MODELS
7L-13-2376 (REV. C)


BATTERY
BUS BAR
FRONT J-BOX
6A
19
37P-WH/BK/RD-18
(P-4)
18
1
2
3
4
37-WH/RD-18
(P-4)
13
37-WH/RD-18
44
LH STOP
REQUEST
SWITCH
1
1
2
2
19L-MR-16
19L-MR-16
19P-MR-16
37-WH/RD-16
19-MR-16
LH TAPE
SWITCH
36-WH-18
1
2
19-BK-18
1
1
2
2
19R-MR-16
19R-MR-16
CHIME
RH STOP
REQUEST
SWITCH
19-BK-18
19-BK-18
RH TAPE
SWITCH
36-WH-18
1
2
36R-WH-16
STOP
REQUEST
RELAY
STOP
REQUEST
LAMPS
19A-MR-16
37A-WH/RD-16
6
3
1
4
LATCH
RESET
A
5
9
7
8
B
36-WH-18
36-WH-18
37A-WH/RD-16
19-MR-16
36-WH-16
19A-MR-16
19-MR-16
19-MR-16
STOP REQUEST
TELLTALE LAMP
24STOP-BK-18
(P-2)
11
37G-GR-16
ENTRANCE DOOR
MICRO-SWITCH
(DOOR CLOSED)
(W/ SEDAN DOOR)
OVERHEAD ENTRANCE
DOOR LAMPS
NC
C
2
NO
37G-GR-16
67
36-WH-16
37G-GR-16
37-WH/RD-16
STEPWELL LAMPS

PART NO.	DESCRIPTION	REV.
7L-13-2064	SPEEDOMETER INSTALLATION (DIXSON & SIGMANETICS)	B

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

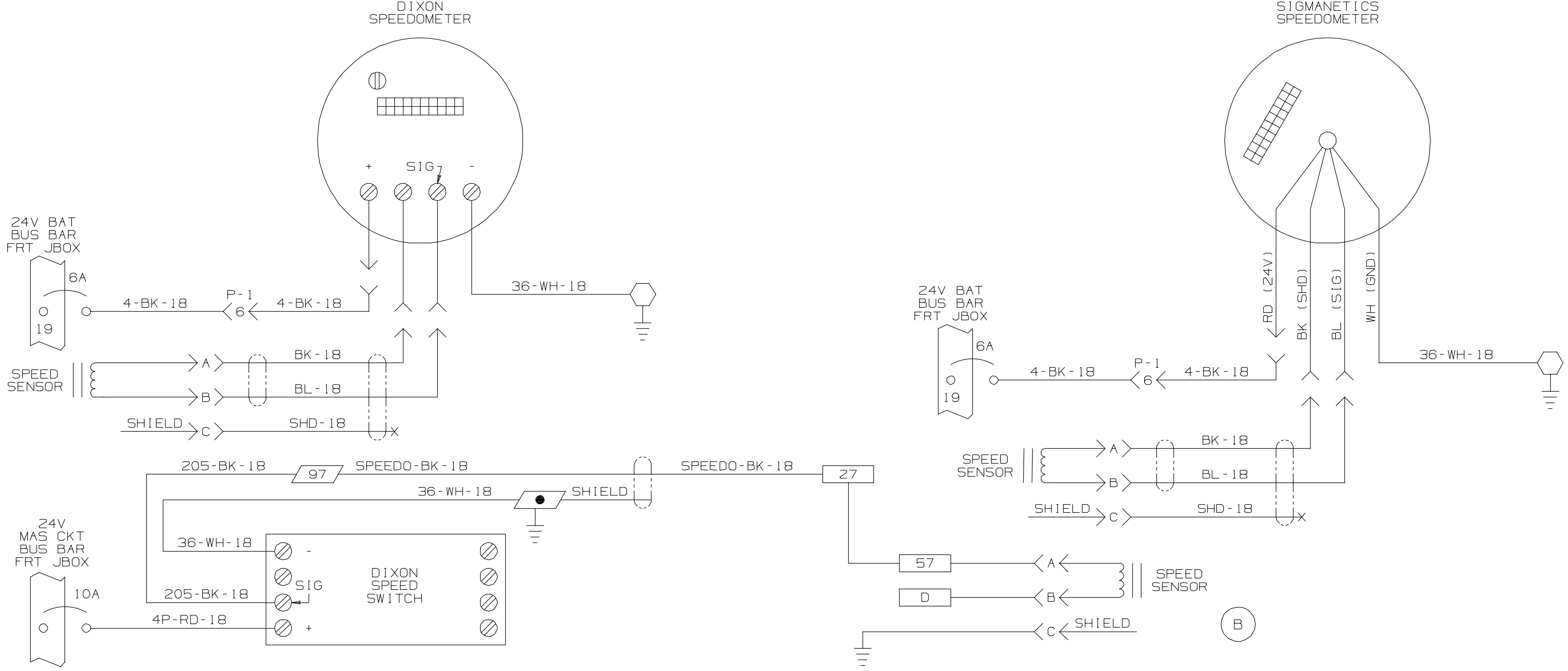
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

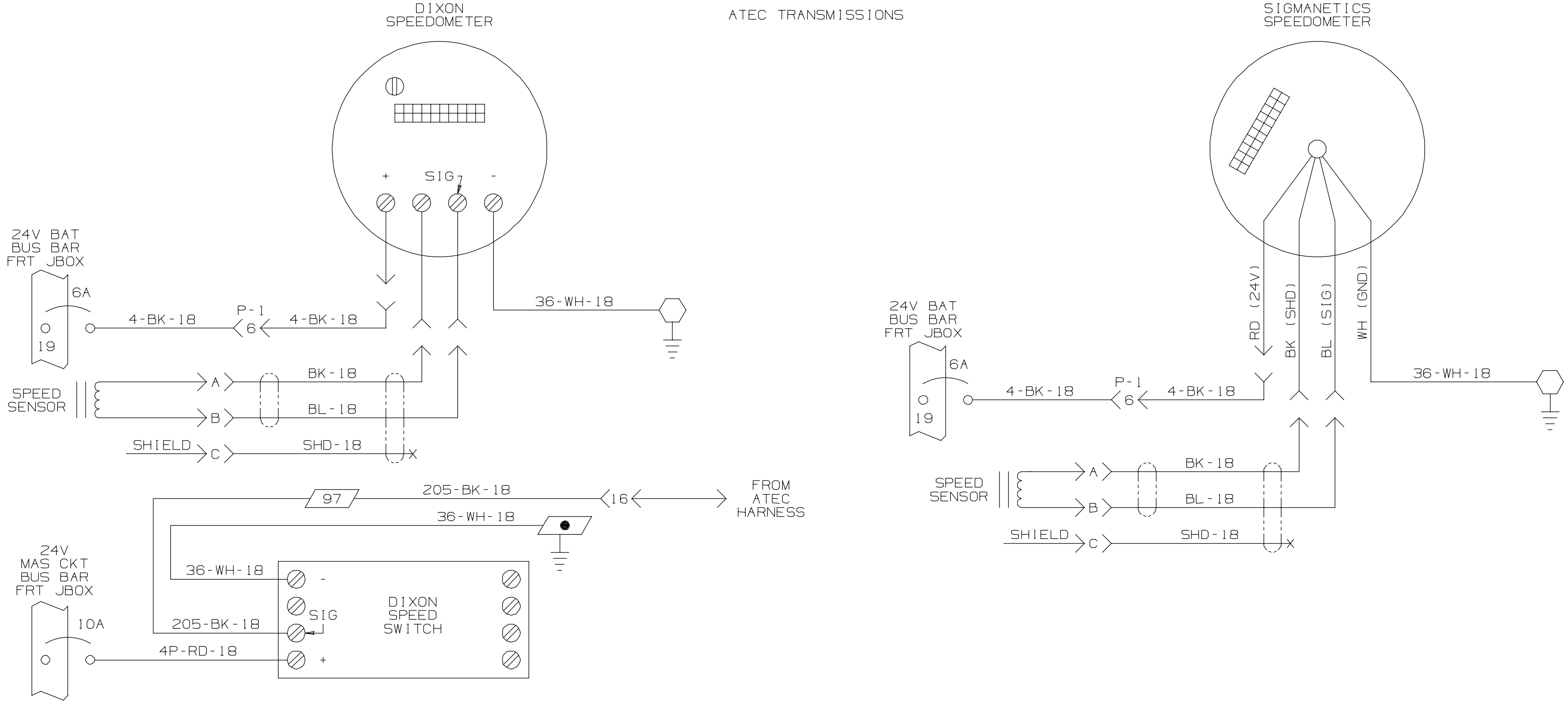
SPEEDOMETER INSTALLATION
DIXSON & SIGMANETICS
102D3 & 102DL3 MODELS
7L-13-2064 (REV. B)

STANDARD/AUTOMATIC TRANSMISSIONS



DIXON SPEEDOMETER
+
SIG
-
24V BAT BUS BAR FRT JBOX
6A
19
4-BK-18
P-1
6
4-BK-18
36-WH-18
SPEED SENSOR
A
B
C
BK-18
BL-18
SHIELD
SHD-18
205-BK-18
97
SPEEDO-BK-18
SPEEDO-BK-18
27
36-WH-18
SHIELD
24V MAS CKT BUS BAR FRT JBOX
10A
36-WH-18
205-BK-18
4P-RD-18
DIXON SPEED SWITCH
SIG
57
D
SIGMANETICS SPEEDOMETER
RD (24V)
BK (SHD)
BL (SIG)
WH (GND)
24V BAT BUS BAR FRT JBOX
6A
19
4-BK-18
P-1
6
4-BK-18
36-WH-18
SPEED SENSOR
BK-18
BL-18
SHIELD
SHD-18
B

ATEC TRANSMISSIONS



DIXON SPEEDOMETER
+
SIG
-
24V BAT BUS BAR FRT JBOX
6A
19
4-BK-18
P-1
6
4-BK-18
36-WH-18
SPEED SENSOR
A
B
C
BK-18
BL-18
SHIELD
SHD-18
97
205-BK-18
16
FROM ATEC HARNESS
36-WH-18
24V MAS CKT BUS BAR FRT JBOX
10A
36-WH-18
205-BK-18
4P-RD-18
DIXON SPEED SWITCH
SIG
SIGMANETICS SPEEDOMETER
RD (24V)
BK (SHD)
BL (SIG)
WH (GND)
24V BAT BUS BAR FRT JBOX
6A
19
4-BK-18
P-1
6
4-BK-18
36-WH-18
SPEED SENSOR
BK-18
BL-18
SHIELD
SHD-18

PART NO.	DESCRIPTION	REV.
7L-13-2092	BAGGAGE DOOR WARNING	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

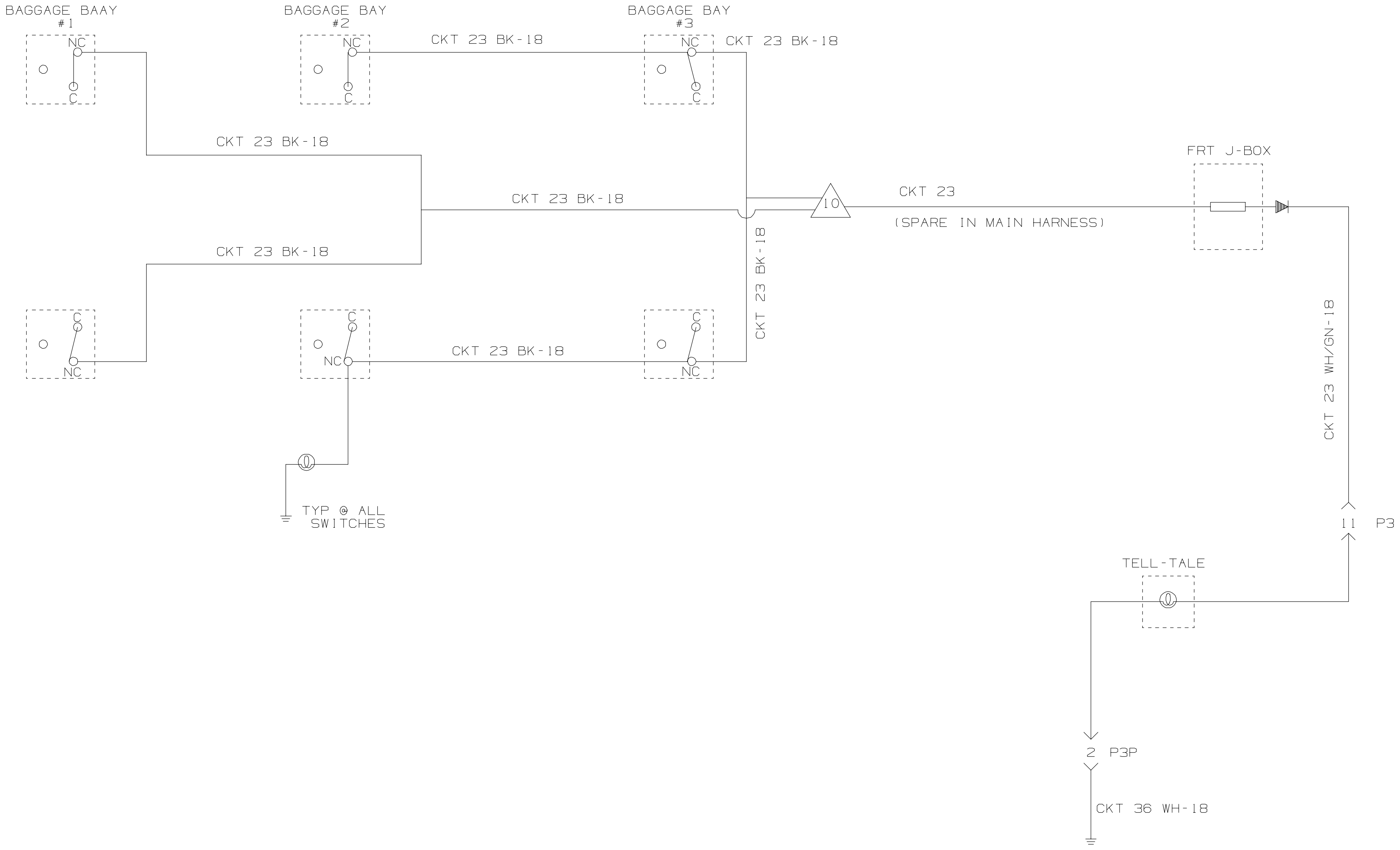
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

BAGGAGE DOOR TELLTALE WARNING CIRCUIT
102D3 & 102DL3 MODELS
7L-13-2092 (REV. B)


BAGGAGE BAAY
#1
BAGGAGE BAY
#2
BAGGAGE BAY
#3
NC
C
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
10
CKT 23
(SPARE IN MAIN HARNESS)
FRT J-BOX
CKT 23 WH/GN-18
11 P3
TYP @ ALL
SWITCHES
TELL-TALE
2 P3P
CKT 36 WH-18

PART NO.	DESCRIPTION	REV.
7L-13-2858	REAR RISE FEATURE (AUTOMATIC)	C

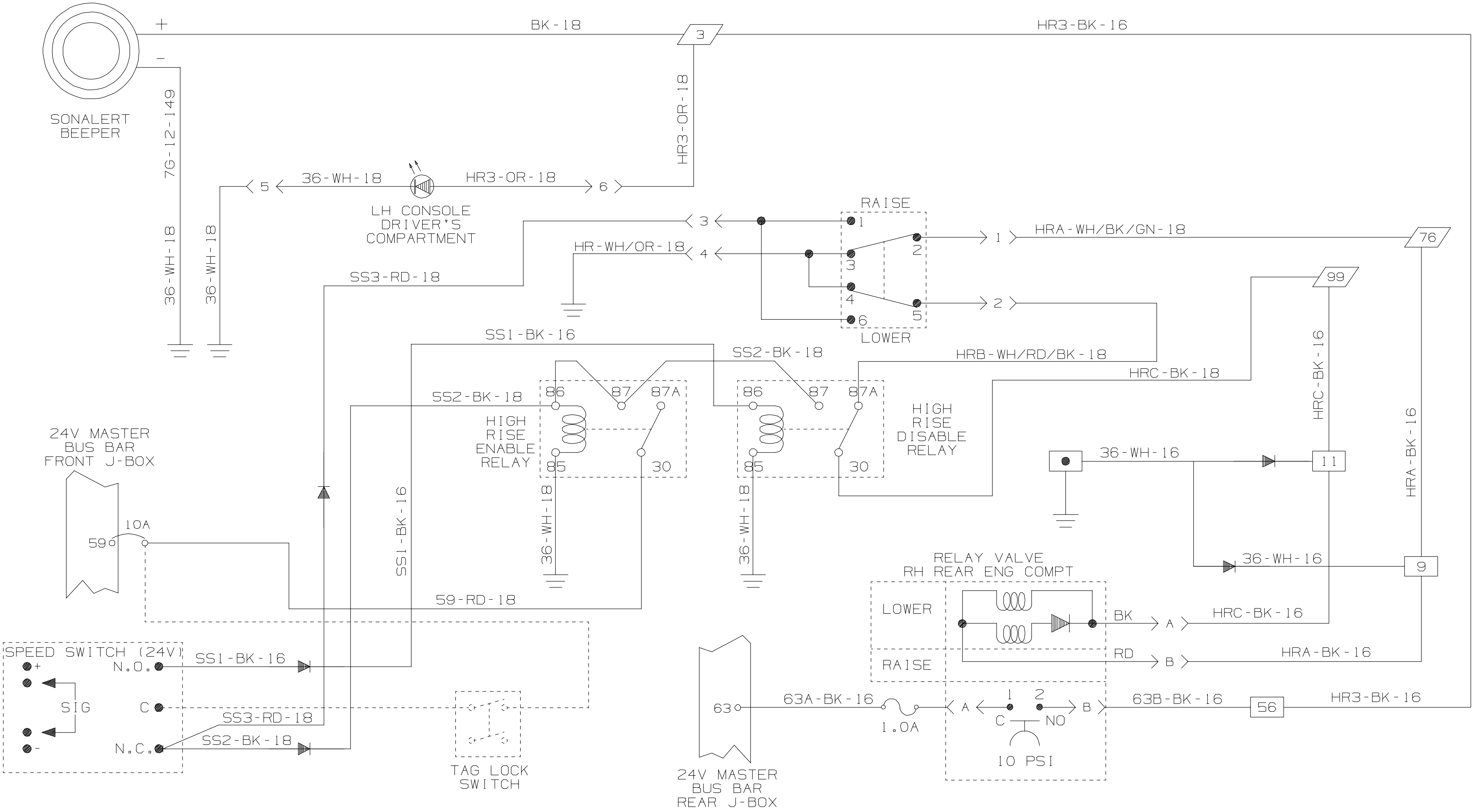
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

REAR RISE FEATURE (AUTOMATIC)
102D3 & 102DL3 MODELS
7L-13-2858 (REV. C)


SONALERT
BEEPER
+
-
BK-18
3
HR3-BK-16
7G-12-149
36-WH-18
36-WH-18
HR3-OR-18
5
36-WH-18
HR3-OR-18
6
LH CONSOLE
DRIVER'S
COMPARTMENT
RAISE
LOWER
3
4
1
2
3
4
5
6
1
2
SS3-RD-18
HR-WH/OR-18
HRA-WH/BK/GN-18
76
99
SS1-BK-16
SS2-BK-18
HRB-WH/RD/BK-18
HRC-BK-18
HRC-BK-16
HRA-BK-16
SS2-BK-18
86
87
87A
85
30
HIGH
RISE
ENABLE
RELAY
86
87
87A
85
30
HIGH
RISE
DISABLE
RELAY
36-WH-18
36-WH-18
24V MASTER
BUS BAR
FRONT J-BOX
59
10A
SS1-BK-16
59-RD-18
36-WH-16
11
36-WH-16
9
RELAY VALVE
RH REAR ENG COMPT
LOWER
RAISE
BK
A
HRC-BK-16
RD
B
HRA-BK-16
SPEED SWITCH (24V)
+
SIG
-
N.O.
C
N.C.
SS1-BK-16
SS3-RD-18
SS2-BK-18
TAG LOCK
SWITCH
24V MASTER
BUS BAR
REAR J-BOX
63
63A-BK-16
1.0A
A
1
2
C
NO
B
10 PSI
63B-BK-16
56
HR3-BK-16

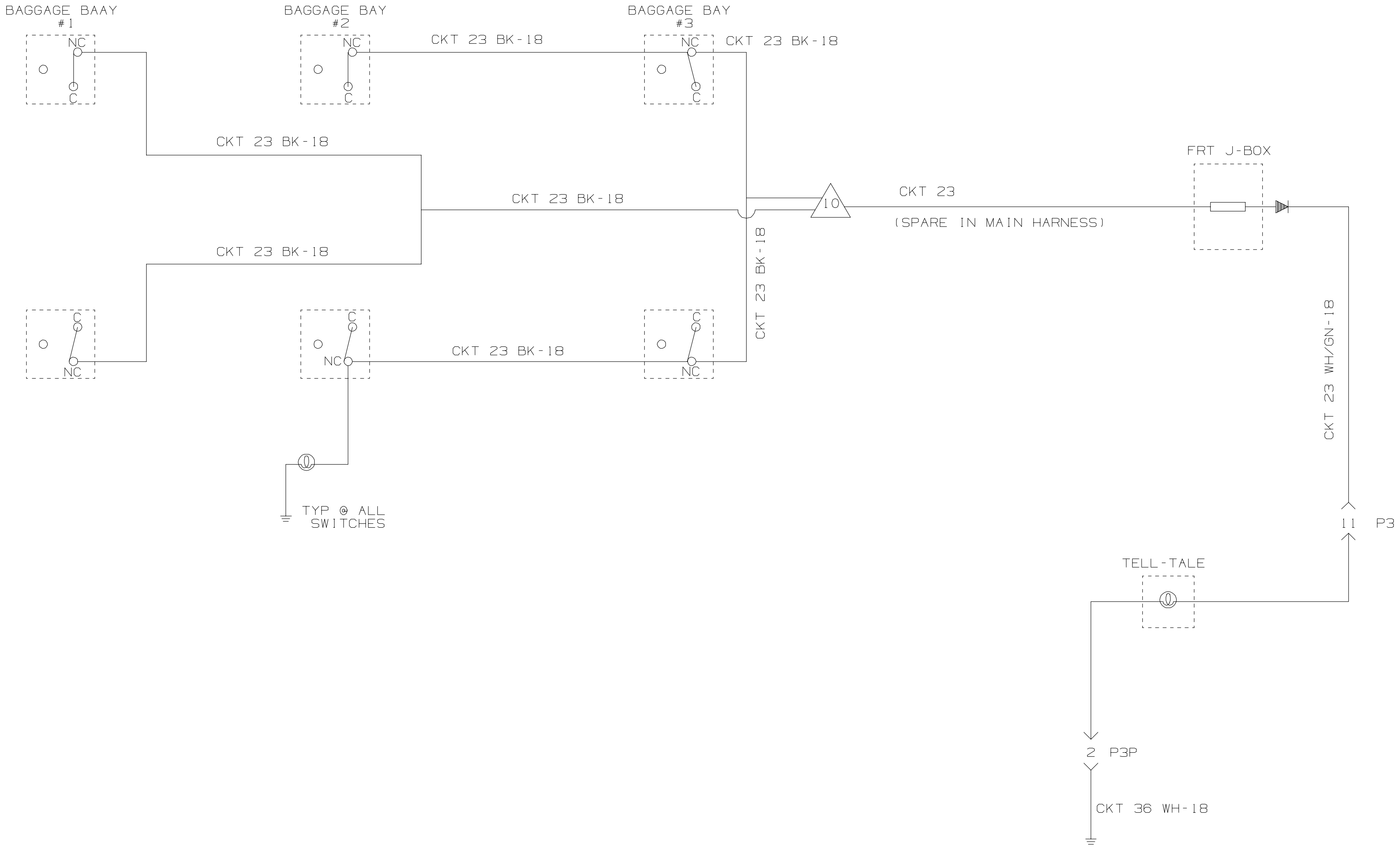
PART NO.	DESCRIPTION	REV.
7L-13-2092	BAGGAGE DOOR WARNING	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

BAGGAGE DOOR TELLTALE WARNING CIRCUIT
102D3 & 102DL3 MODELS
7L-13-2092 (REV. B)


BAGGAGE BAAY
#1
BAGGAGE BAY
#2
BAGGAGE BAY
#3
NC
C
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
CKT 23 BK-18
10
CKT 23
(SPARE IN MAIN HARNESS)
FRT J-BOX
CKT 23 WH/GN-18
11 P3
TYP @ ALL
SWITCHES
TELL-TALE
2 P3P
CKT 36 WH-18

PART NO.	DESCRIPTION	REV.
7L-13-3131	MOTORIZED BLINDS	A

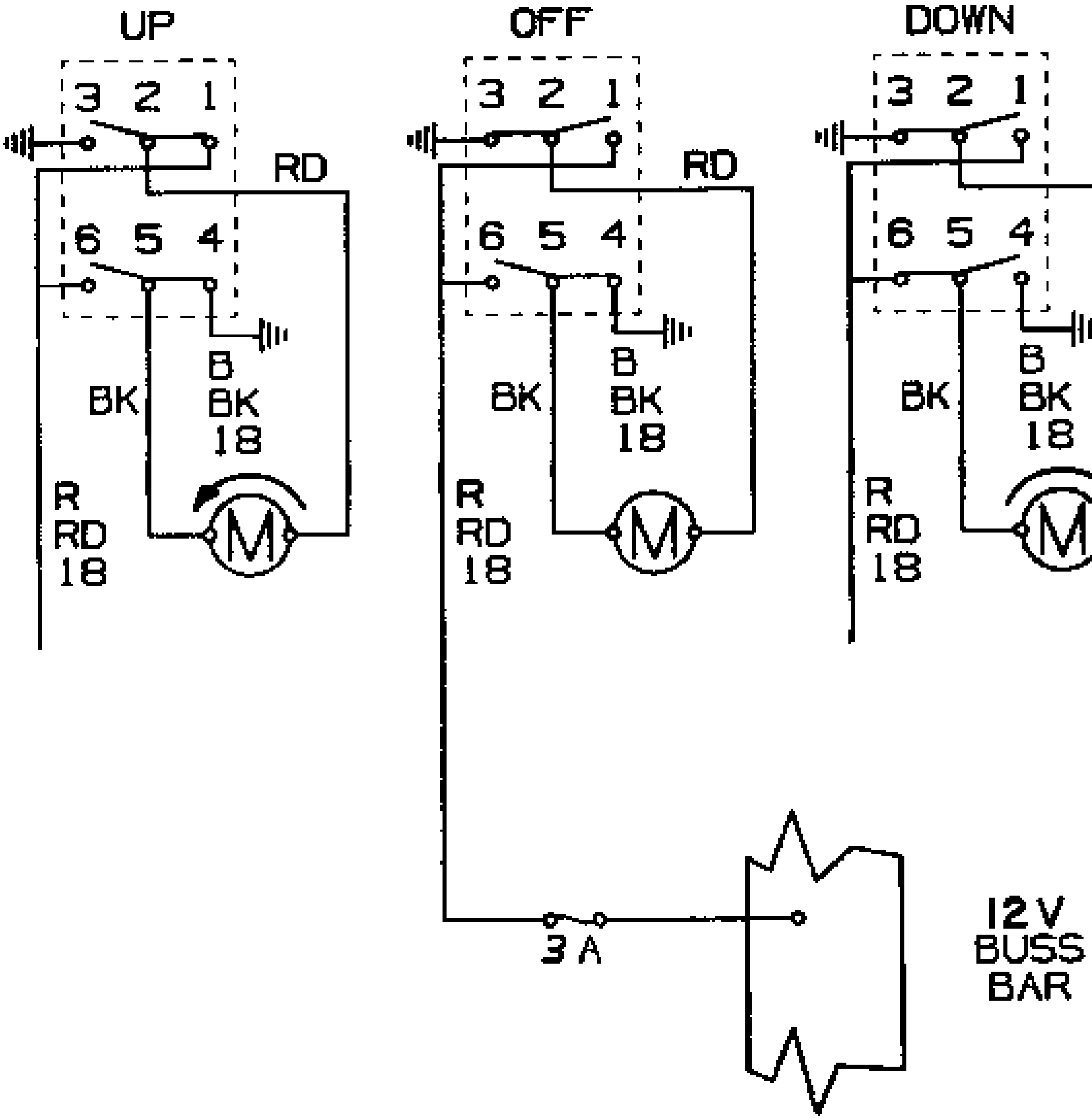
▱	FRT J−BOX STUD BLOCK
▱	FRONT J−BOX STUD
▱	FRT J−BOX ENT STUD BLK
▭	REAR J−BOX STUD BLOCK
▭	REAR J−BOX STUD
△	A/C J−BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▣	REM CONT J−BOX HORIZ STUD BLK
◈	REM CONT J−BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
− −	OPTION

WH−WHITE
GY−GREY
VO−VIOLET
BL−BLUE
GR−GREEN

RD−RED
BR−BROWN
BK−BLACK
YL−YELLOW
OR−ORANGE

LEGEND

MOTORIZED BLINDS
102D3 & 102DL3
7L−13−3131 (REV A)


UP
OFF
DOWN
3 2 1
6 5 4
RD
BK
B
BK
18
R
RD
18
M
3 A
12 V
BUSS
BAR

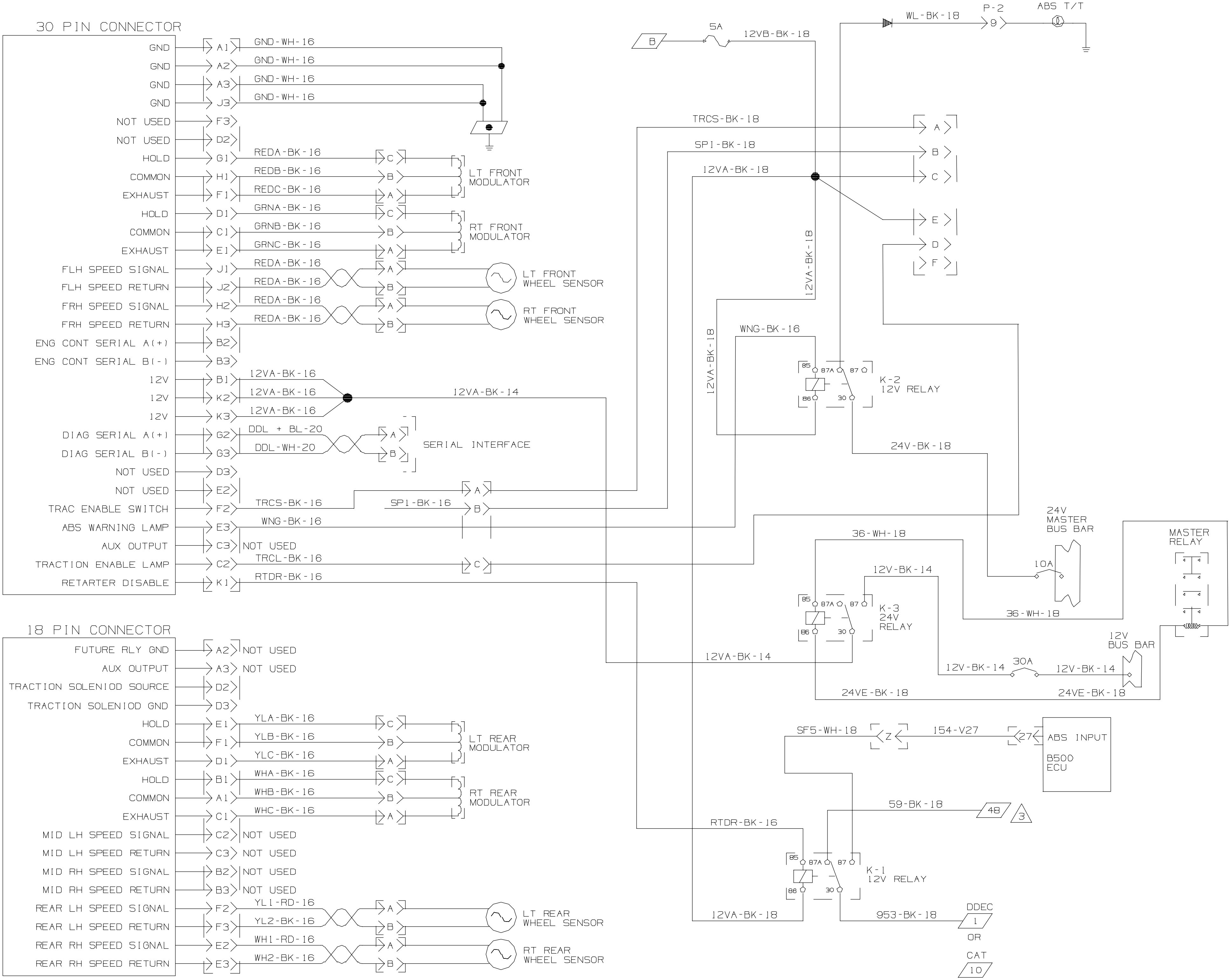
PART NO.	DESCRIPTION	REV.
7L-13-3340	**ANTILOCK BRAKE SYSTEM**	**C**

▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
△	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE	RD—RED
GY—GREY	BR—BROWN
VO—VIOLET	BK—BLACK
BL—BLUE	YL—YELLOW
GR—GREEN	OR—ORANGE

LEGEND

ANTILOCK BRAKE SYSTEM
102D3 & 102DL3
7L—13—3340 (REV C)


30 PIN CONNECTOR
GND A1 GND-WH-16
GND A2 GND-WH-16
GND A3 GND-WH-16
GND J3 GND-WH-16
NOT USED F3
NOT USED D2
HOLD G1 REDA-BK-16 C
COMMON H1 REDB-BK-16 B
EXHAUST F1 REDC-BK-16 A
LT FRONT MODULATOR
HOLD D1 GRNA-BK-16 C
COMMON C1 GRNB-BK-16 B
EXHAUST E1 GRNC-BK-16 A
RT FRONT MODULATOR
FLH SPEED SIGNAL J1 REDA-BK-16 A
FLH SPEED RETURN J2 REDA-BK-16 B
LT FRONT WHEEL SENSOR
FRH SPEED SIGNAL H2 REDA-BK-16 A
FRH SPEED RETURN H3 REDA-BK-16 B
RT FRONT WHEEL SENSOR
ENG CONT SERIAL A(+) B2
ENG CONT SERIAL B(-) B3
12V B1 12VA-BK-16
12V K2 12VA-BK-16
12V K3 12VA-BK-16
12VA-BK-14
DIAG SERIAL A(+) G2 DDL + BL-20 A
DIAG SERIAL B(-) G3 DDL-WH-20 B
SERIAL INTERFACE
NOT USED D3
NOT USED E2
TRAC ENABLE SWITCH F2 TRCS-BK-16 A
SP1-BK-16 B
ABS WARNING LAMP E3 WNG-BK-16
AUX OUTPUT C3 NOT USED
TRACTION ENABLE LAMP C2 TRCL-BK-16 C
RETARTER DISABLE K1 RTDR-BK-16
18 PIN CONNECTOR
FUTURE RLY GND A2 NOT USED
AUX OUTPUT A3 NOT USED
TRACTION SOLENIOD SOURCE D2
TRACTION SOLENIOD GND D3
HOLD E1 YLA-BK-16 C
COMMON F1 YLB-BK-16 B
EXHAUST D1 YLC-BK-16 A
LT REAR MODULATOR
HOLD B1 WHA-BK-16 C
COMMON A1 WHB-BK-16 B
EXHAUST C1 WHC-BK-16 A
RT REAR MODULATOR
MID LH SPEED SIGNAL C2 NOT USED
MID LH SPEED RETURN C3 NOT USED
MID RH SPEED SIGNAL B2 NOT USED
MID RH SPEED RETURN B3 NOT USED
REAR LH SPEED SIGNAL F2 YL1-RD-16 A
REAR LH SPEED RETURN F3 YL2-BK-16 B
LT REAR WHEEL SENSOR
REAR RH SPEED SIGNAL E2 WH1-RD-16 A
REAR RH SPEED RETURN E3 WH2-BK-16 B
RT REAR WHEEL SENSOR
B
5A
12VB-BK-18
WL-BK-18
P-2
9
ABS T/T
TRCS-BK-18
A
SP1-BK-18
B
12VA-BK-18
C
E
D
F
12VA-BK-18
12VA-BK-18
WNG-BK-16
85
87A
87
86
30
K-2
12V RELAY
24V-BK-18
24V MASTER BUS BAR
10A
MASTER RELAY
36-WH-18
12V-BK-14
85
87A
87
86
30
K-3
24V RELAY
36-WH-18
12VA-BK-14
12V-BK-14
30A
12V-BK-14
12V BUS BAR
24VE-BK-18
24VE-BK-18
SF5-WH-18
Z
154-V27
27
ABS INPUT
B500 ECU
59-BK-18
48
3
RTDR-BK-16
85
87A
87
86
30
K-1
12V RELAY
12VA-BK-18
953-BK-18
DDEC
1
OR
CAT
10

PART NO.	DESCRIPTION	REV.
7L-13-970	INSTRUMENT PANEL (WITH TACHOGRAPH)	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	◬	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

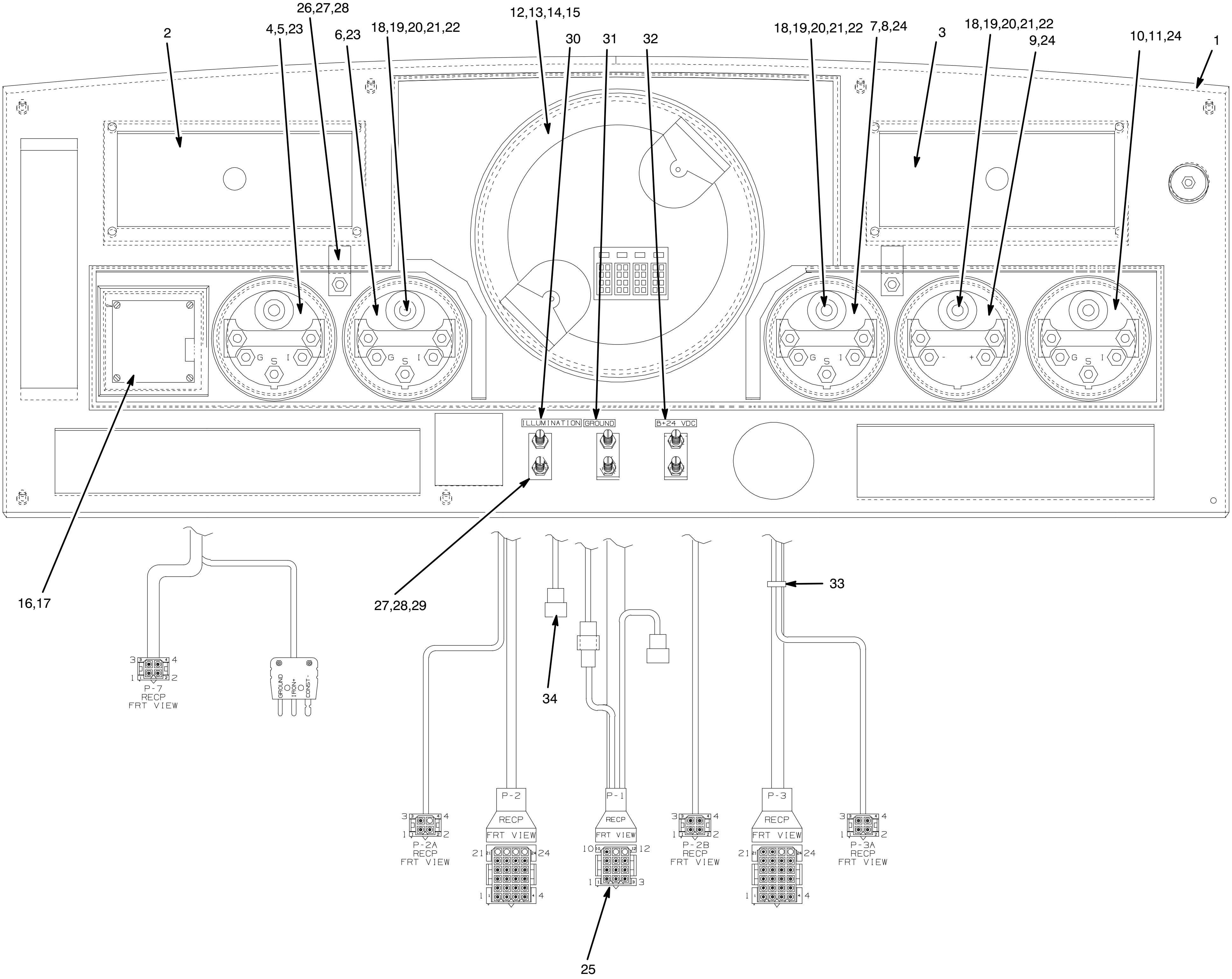
LEGEND

1.	PANEL
2.	TARGET CLUSTER RH
3.	TARGET CLUSTER LH
4.	GAUGE - OIL PRESS
5.	GAUGE - OIL PRESS
6.	GAUGE - FUEL LEVEL
7.	GAUGE - AIR, SM
8.	GAUGE - AIR, SM
9.	GAUGE - VOLTMETER
10.	GAUGE - WATER TEMP
11.	GAUGE - WATER TEMP
12.	TACHOGRAPH
13.	TACHOGRAPH
14.	TACHOGRAPH
15.	TACHOGRAPH
16.	TEMP CONTROL ASSY
17.	TEMP CONTROL ASSY
18.	SOCKET
19.	RETAINER - PLASTIC
20.	CONN - SOCKET
21.	SPRING
22.	LAMP - 28V
23.	ASSY - WIRE HARN
24.	ASSY - WIRE HARN
25.	ASSY - WIRE HARN
26.	CLAMP - PLASTIC
27.	STUD - W/NUT, BRASS
28.	NUT - HEX, BRASS
29.	BUS BAR
30.	DECAL - ILLUM
31.	DECAL - GROUND
32.	DECAL - B+, 24VDC
33.	TYRAP
34.	JUMPER
35.	SCHEMATIC
36.	ASSY - WIRE HARN
37.	INSTRUMENT PANEL, GRAPHIC DISPLAY

INSTRUMENT PANEL INSTALLATION

TACHOGRAPH

7L-13-970 (REV B)


2
4,5,23
26,27,28
6,23
18,19,20,21,22
12,13,14,15
30
31
32
18,19,20,21,22
7,8,24
3
18,19,20,21,22
9,24
10,11,24
1
G S I
G S I
G S I
- +
G S I
ILLUMINATION
GROUND
B+24 VDC
16,17
27,28,29
33
34
25
3 4
1 2
P-7
RECP
FRT VIEW
GROUND
IRON+
CONST-
3 4
1 2
P-2A
RECP
FRT VIEW
P-2
RECP
FRT VIEW
21 24
1 4
P-1
RECP
FRT VIEW
10 12
1 3
3 4
1 2
P-2B
RECP
FRT VIEW
P-3
RECP
FRT VIEW
21 24
1 4
3 4
1 2
P-3A
RECP
FRT VIEW

PART NO.	DESCRIPTION	REV.
7L-13-957	**INSTRUMENT PANEL**	**D**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

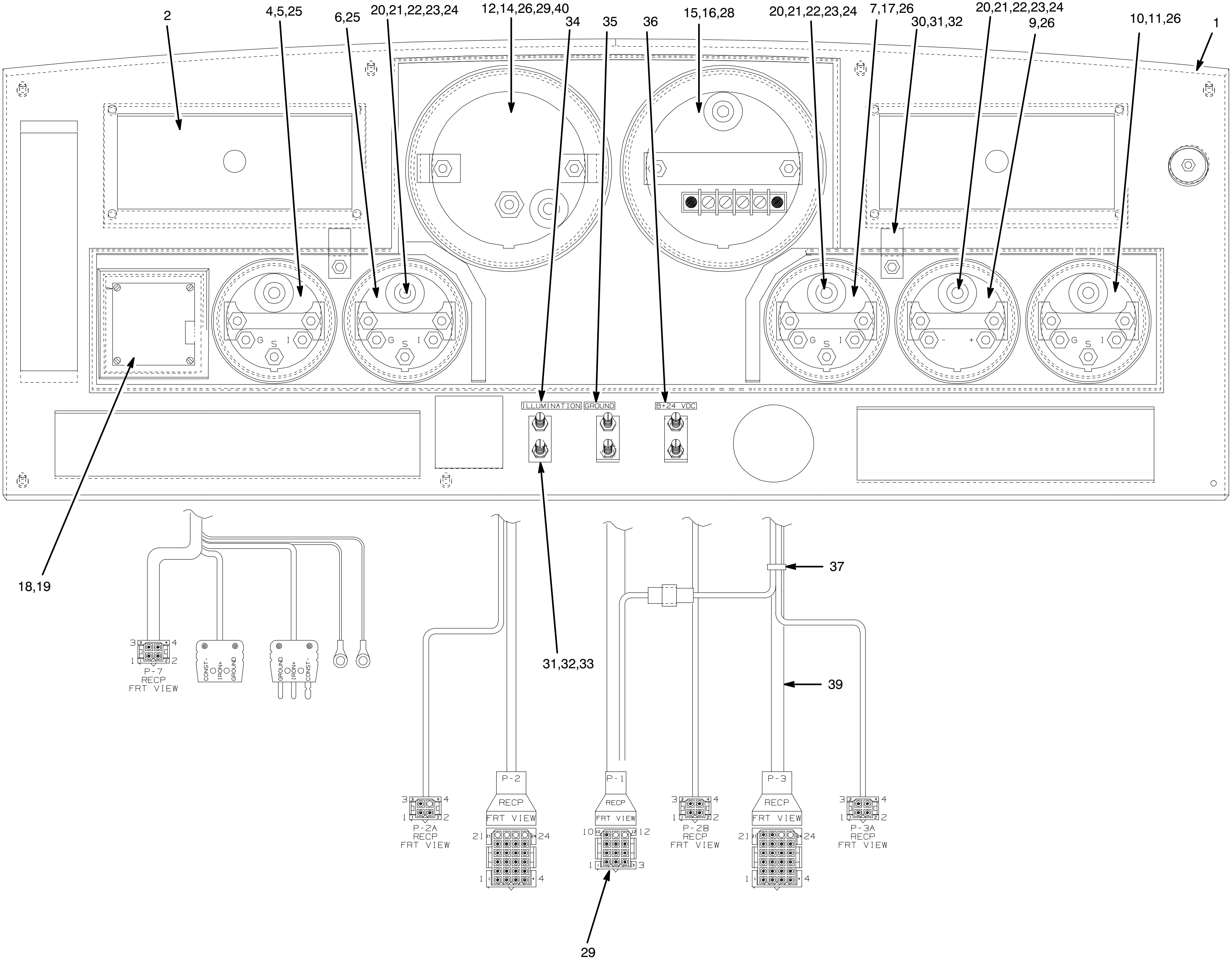
LEGEND

1.	PANEL
2.	TARGET CLUSTER RH
3.	TARGET CLUSTER LH
4.	GAUGE - OIL PRESS
5.	GAUGE - OIL PRESS
6.	GAUGE - FUEL LEVEL
7.	GAUGE - AIR, SM
8.	
9.	GAUGE - VOLTMETER
10.	GAUGE - WATER TEMP
11.	GAUGE - WATER TEMP
12.	GAUGE - AIR, LG
13.	
14.	TACHOMETER
15.	SPEEDOMETER, DOMESTIC
16.	SPEEDOMETER, METRIC
17.	PLUG, GAUGE WELL
18.	TEMP CONTROL ASSY
19.	TEMP CONTROL ASSY
20.	SOCKET
21.	RETAINER - PLASTIC
22.	SOCKET
23.	SPRING
24.	LAMP - 26V
25.	ASSY - WIRE HARN
26.	ASSY - WIRE HARN
27.	
28.	WIRE HARN, DIXON SPEEDO
29.	ASSY - WIRE HARN
30.	CLAMP - PLASTIC
31.	STUD - BRASS W/NUT
32.	NUT - HEX, BRASS
33.	BUS BAR
34.	DECAL - ILLUM
35.	DECAL - GROUND
36.	DECAL - B+, 24 VDC
37.	TYRAP
38.	SCHEMATIC
39.	ASSY - WIRE HARN
40.	BRACKET MOUNTING

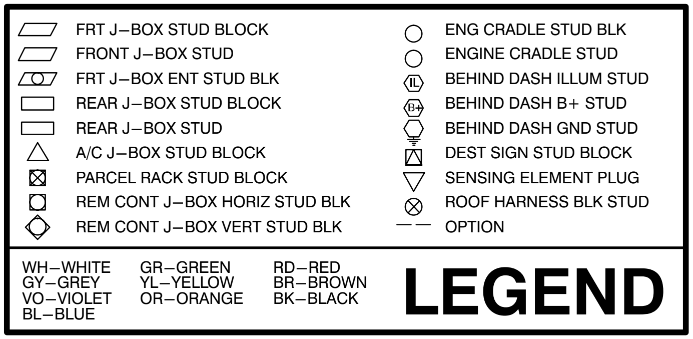
INSTRUMENT PANEL W/SPEEDOMETER

102D3 & 102DL3

7L-13-957 (REV D)


2
4,5,25
6,25
20,21,22,23,24
12,14,26,29,40
34
35
36
15,16,28
20,21,22,23,24
7,17,26
30,31,32
20,21,22,23,24
9,26
10,11,26
1
ILLUMINATION
GROUND
B+24 VDC
G S I
G S I
G S I
- +
G S I
18,19
31,32,33
37
39
3 4 1 2
P-7
RECP
FRT VIEW
CONST-
IRON+
GROUND
GROUND
IRON+
CONST-
3 4 1 2
P-2A
RECP
FRT VIEW
P-2
RECP
FRT VIEW
21 24 1 4
P-1
RECP
FRT VIEW
10 12 1 3
3 4 1 2
P-2B
RECP
FRT VIEW
P-3
RECP
FRT VIEW
21 24 1 4
3 4 1 2
P-3A
RECP
FRT VIEW
29

PART NO.	DESCRIPTION	REV.
7L-13-998	DECAL INSTALLATION REAR J-BOX (102DL3)	C



▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⧗	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

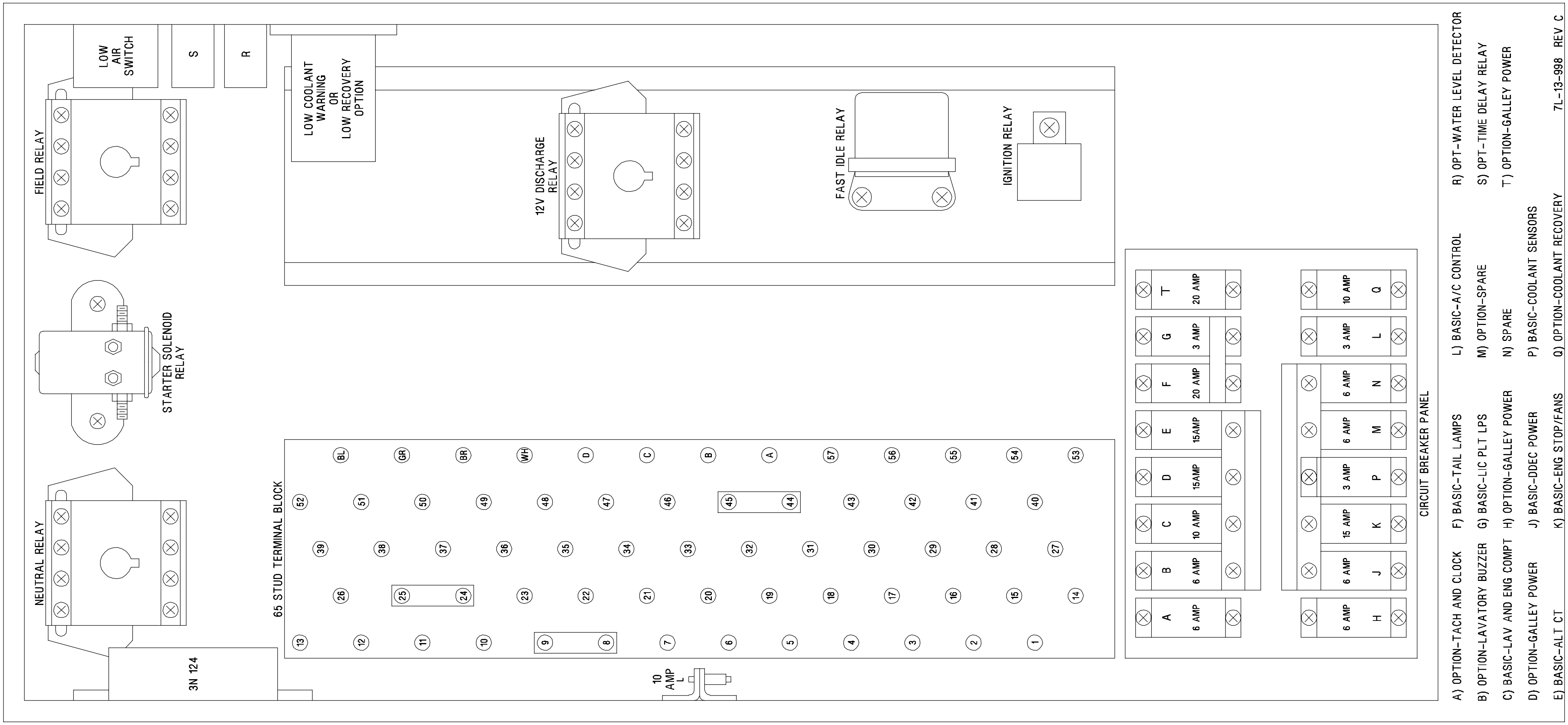
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

REAR JUNCTION BOX DECAL
102DL3 MODELS ONLY
7L-13-998 (REV C)


LOW AIR SWITCH
S
R
LOW COOLANT WARNING OR LOW RECOVERY OPTION
FIELD RELAY
12V DISCHARGE RELAY
FAST IDLE RELAY
IGNITION RELAY
STARTER SOLENOID RELAY
NEUTRAL RELAY
65 STUD TERMINAL BLOCK
BL
GR
BR
WH
D
C
B
A
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
3N 124
10 AMP L
CIRCUIT BREAKER PANEL
T 20 AMP
G 3 AMP
F 20 AMP
E 15AMP
D 15AMP
C 10 AMP
B 6 AMP
A 6 AMP
Q 10 AMP
L 3 AMP
N 6 AMP
M 6 AMP
P 3 AMP
K 15 AMP
J 6 AMP
H 6 AMP

A) OPTION–TACH AND CLOCK
B) OPTION–LAVATORY BUZZER
C) BASIC–LAV AND ENG COMPT
D) OPTION–GALLEY POWER
E) BASIC–ALT CT

F) BASIC–TAIL LAMPS
G) BASIC–LIC PLT LPS
H) OPTION–GALLEY POWER
J) BASIC–DDEC POWER
K) BASIC–ENG STOP/FANS

L) BASIC–A/C CONTROL
M) OPTION–SPARE
N) SPARE
P) BASIC–COOLANT SENSORS
Q) OPTION–COOLANT RECOVERY

R) OPT–WATER LEVEL DETECTOR
S) OPT–TIME DELAY RELAY
T) OPTION–GALLEY POWER

7L–13–998 REV C

PART NO.	DESCRIPTION	REV.
7L-13-2513	IN-STATION LIGHTING	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	◪	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

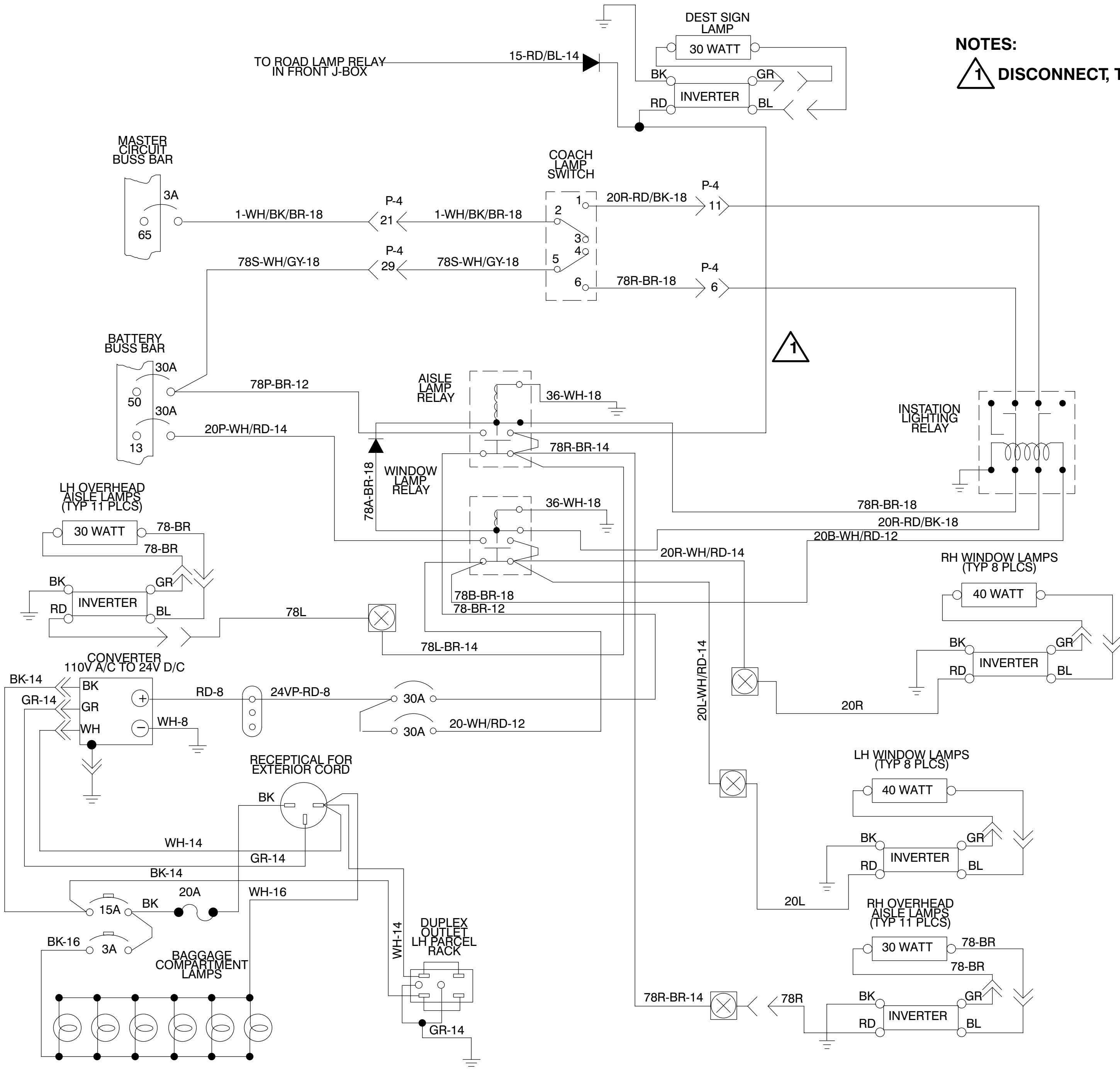
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

IN-STATION LIGHTING INSTALLATION
PARCEL RACK OVERHEAD WINDOW & AISLE LAMPS
102D3 & 102DL3 MODELS
7L-13-2513 (REV. A)


DEST SIGN LAMP
30 WATT
BK
GR
INVERTER
RD
BL
TO ROAD LAMP RELAY IN FRONT J-BOX
15-RD/BL-14
MASTER CIRCUIT BUSS BAR
3A
65
1-WH/BK/BR-18
P-4
21
1-WH/BK/BR-18
COACH LAMP SWITCH
1
2
3
4
5
6
20R-RD/BK-18
P-4
11
78S-WH/GY-18
P-4
29
78S-WH/GY-18
78R-BR-18
P-4
6
1
BATTERY BUSS BAR
30A
50
30A
13
78P-BR-12
20P-WH/RD-14
AISLE LAMP RELAY
36-WH-18
78R-BR-14
78A-BR-18
WINDOW LAMP RELAY
36-WH-18
INSTATION LIGHTING RELAY
78R-BR-18
20R-RD/BK-18
20B-WH/RD-12
20R-WH/RD-14
78B-BR-18
78-BR-12
LH OVERHEAD AISLE LAMPS (TYP 11 PLCS)
30 WATT
78-BR
78-BR
BK
GR
INVERTER
RD
BL
78L
78L-BR-14
RH WINDOW LAMPS (TYP 8 PLCS)
40 WATT
BK
GR
INVERTER
RD
BL
20R
20L-WH/RD-14
CONVERTER 110V A/C TO 24V D/C
BK-14
BK
GR-14
GR
WH
+
−
RD-8
24VP-RD-8
WH-8
30A
30A
20-WH/RD-12
RECEPTICAL FOR EXTERIOR CORD
BK
WH-14
GR-14
BK-14
WH-16
15A
BK
20A
BK-16
3A
BAGGAGE COMPARTMENT LAMPS
WH-14
DUPLEX OUTLET LH PARCEL RACK
GR-14
LH WINDOW LAMPS (TYP 8 PLCS)
40 WATT
BK
GR
INVERTER
RD
BL
20L
RH OVERHEAD AISLE LAMPS (TYP 11 PLCS)
30 WATT
78-BR
78-BR
BK
GR
INVERTER
RD
BL
78R-BR-14
78R

NOTES:

1 **DISCONNECT, TAPE BACK WIRE AT AISLE LAMP RELAY**

PART NO.	DESCRIPTION	REV.
7L-13-337	CONTROL PANEL ILLUMINATION	C

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
⧇	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

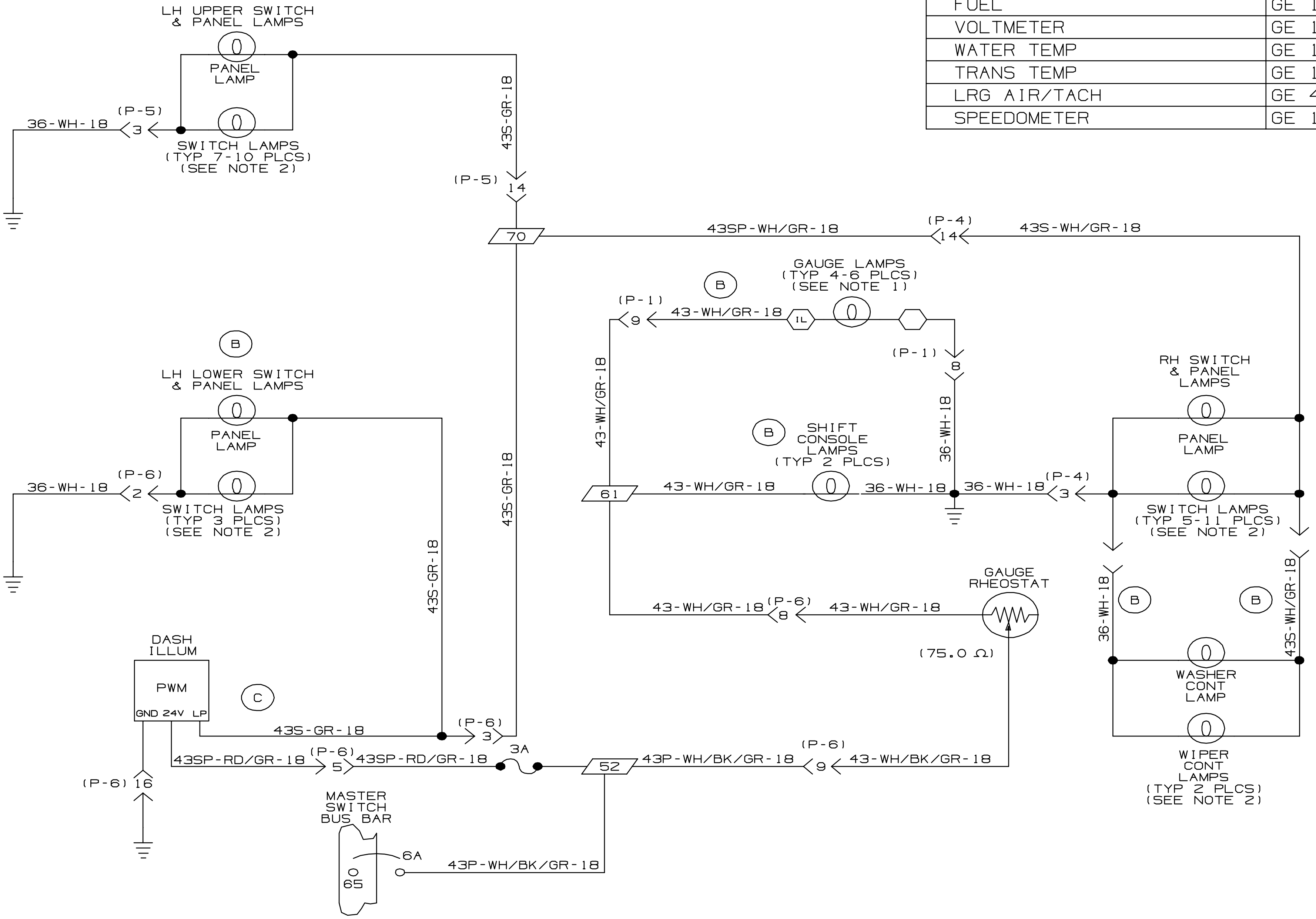
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

CONTROL PANEL ILLUMINATION
102D3 & 102DL3
7L–13–337 (REV C)

LAMP BREAKDOWN	TYPE
MESSAGE STRIPS-ALL LAMPS	GE 85
MICRO SWITCHES-ALL LAMPS	GE 85
W/S WIPER & WASHER RH & LH	GE 85
GEAR SHIFT ILLUM	GE 265
GAUGES	
OIL	GE 1829
FUEL	GE 1829
VOLTMETER	GE 1829
WATER TEMP	GE 1829
TRANS TEMP	GE 1829
LRG AIR/TACH	GE 456
SPEEDOMETER	GE 1864


LH UPPER SWITCH & PANEL LAMPS
PANEL LAMP
(P-5) 3
36-WH-18
SWITCH LAMPS (TYP 7-10 PLCS) (SEE NOTE 2)
43S-GR-18
(P-5) 14
70
43SP-WH/GR-18
(P-4) 14
43S-WH/GR-18
B
GAUGE LAMPS (TYP 4-6 PLCS) (SEE NOTE 1)
(P-1) 9
43-WH/GR-18
IL
(P-1) 8
43-WH/GR-18
36-WH-18
B
LH LOWER SWITCH & PANEL LAMPS
PANEL LAMP
(P-6) 2
36-WH-18
SWITCH LAMPS (TYP 3 PLCS) (SEE NOTE 2)
43S-GR-18
43S-GR-18
B
SHIFT CONSOLE LAMPS (TYP 2 PLCS)
61
43-WH/GR-18
36-WH-18
36-WH-18
(P-4) 3
RH SWITCH & PANEL LAMPS
PANEL LAMP
SWITCH LAMPS (TYP 5-11 PLCS) (SEE NOTE 2)
36-WH-18
B
B
43S-WH/GR-18
WASHER CONT LAMP
WIPER CONT LAMPS (TYP 2 PLCS) (SEE NOTE 2)
GAUGE RHEOSTAT
(75.0 Ω)
43-WH/GR-18
(P-6) 8
43-WH/GR-18
DASH ILLUM
PWM
GND 24V LP
C
43S-GR-18
(P-6) 3
(P-6) 16
43SP-RD/GR-18
(P-6) 5
43SP-RD/GR-18
3A
52
43P-WH/BK/GR-18
(P-6) 9
43-WH/BK/GR-18
MASTER SWITCH BUS BAR
6A
65
43P-WH/BK/GR-18

PART NO.	DESCRIPTION	REV.
7L-13-391	EXTERIOR MIRROR INSTALLATION	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

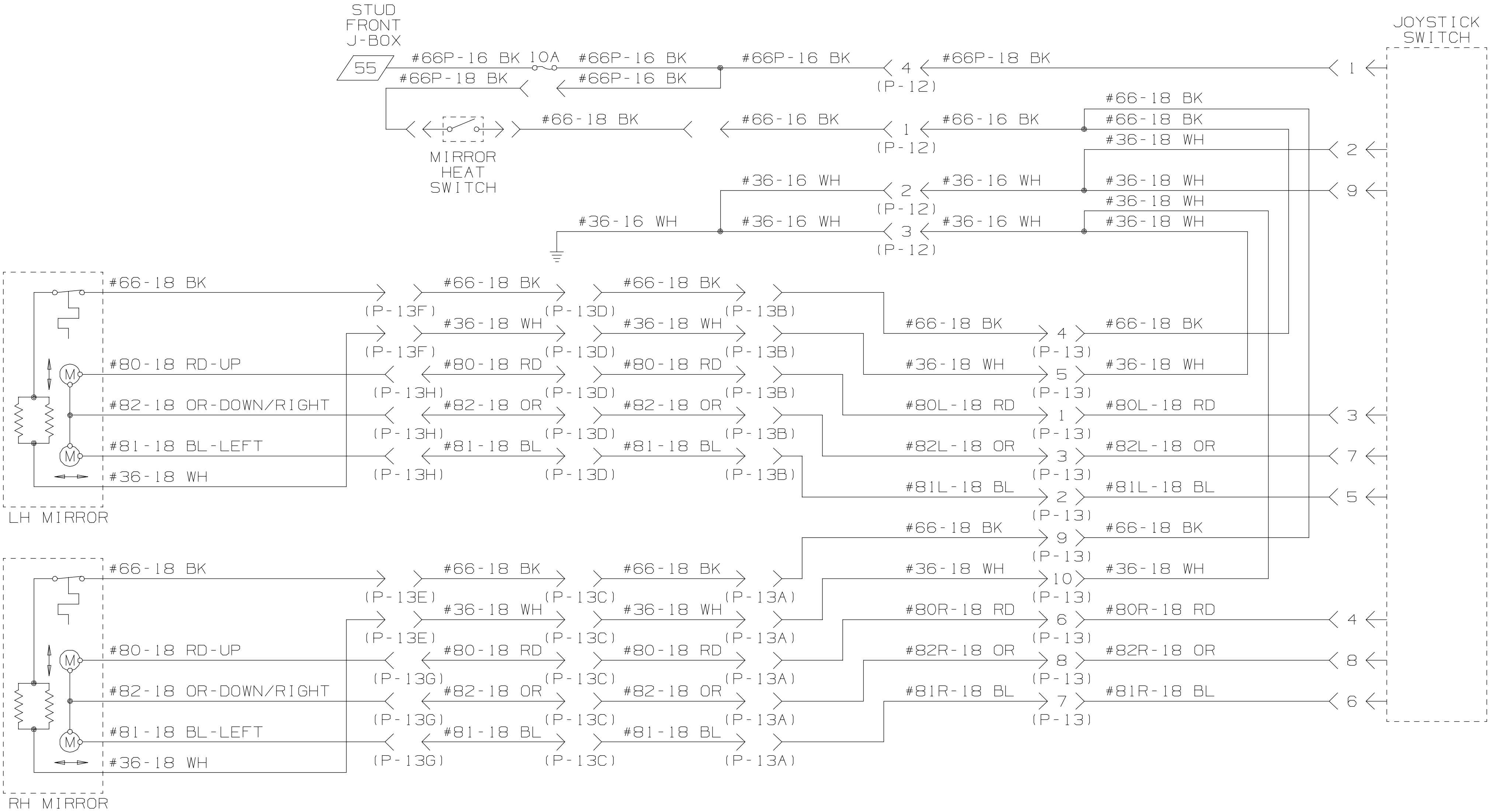
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

EXTERIOR MIRROR INSTALLATION
102D3 & 102DL3 MODELS

7L-13-391 (REV. A)


STUD FRONT J-BOX
55
#66P-16 BK
10A
#66P-16 BK
#66P-16 BK
#66P-18 BK
#66P-18 BK
#66P-16 BK
4 (P-12)
MIRROR HEAT SWITCH
#66-18 BK
#66-16 BK
1 (P-12)
#66-16 BK
#66-18 BK
#66-18 BK
#36-18 WH
#36-16 WH
2 (P-12)
#36-16 WH
#36-18 WH
#36-18 WH
#36-16 WH
#36-16 WH
3 (P-12)
#36-16 WH
#36-18 WH
JOYSTICK SWITCH
1
2
9
3
7
5
4
8
6
LH MIRROR
#66-18 BK
#36-18 WH
#80-18 RD-UP
#82-18 OR-DOWN/RIGHT
#81-18 BL-LEFT
M
(P-13F)
(P-13H)
(P-13D)
(P-13B)
#66-18 BK
#36-18 WH
#80-18 RD
#82-18 OR
#81-18 BL
#66-18 BK
#36-18 WH
#80L-18 RD
#82L-18 OR
#81L-18 BL
4 (P-13)
5 (P-13)
1 (P-13)
3 (P-13)
2 (P-13)
9 (P-13)
10 (P-13)
6 (P-13)
8 (P-13)
7 (P-13)
RH MIRROR
(P-13E)
(P-13G)
(P-13C)
(P-13A)
#80R-18 RD
#82R-18 OR
#81R-18 BL

PART NO.	DESCRIPTION	REV.
7L-13-1157	**ANTI-LOCK BRAKE SYSTEM**	**B**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

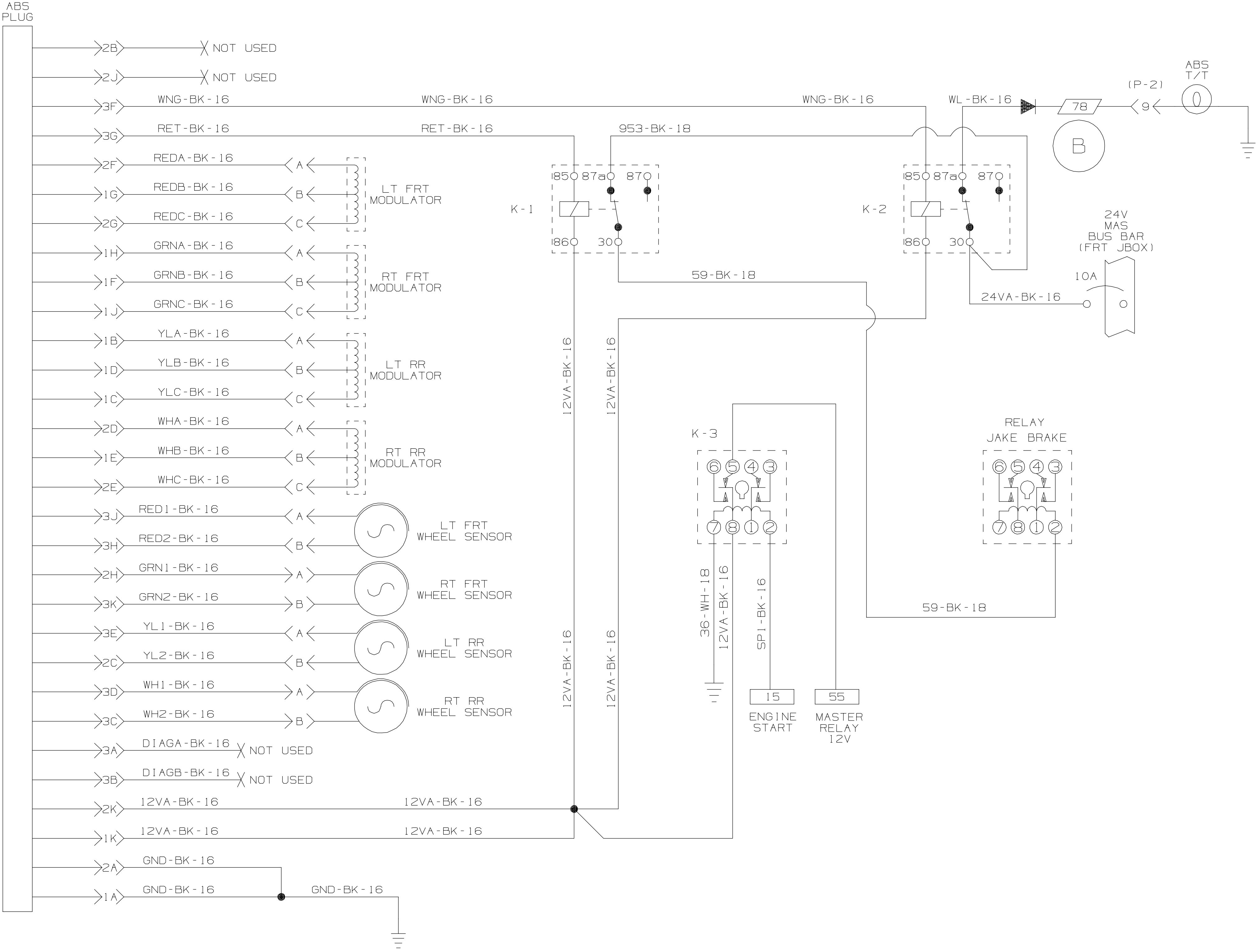
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
YL–YELLOW
OR–ORANGE
RD–RED
BR–BROWN
BK–BLACK

LEGEND

ANTI-LOCK BRAKE SYSTEM

102DL3 MODELS ONLY

7L-13-1157 (REV B)


ABS PLUG
2B
NOT USED
2J
NOT USED
3F
WNG-BK-16
WNG-BK-16
WNG-BK-16
WL-BK-16
78
(P-2)
9
ABS T/T
B
3G
RET-BK-16
RET-BK-16
953-BK-18
2F
REDA-BK-16
A
1G
REDB-BK-16
B
2G
REDC-BK-16
C
LT FRT MODULATOR
1H
GRNA-BK-16
A
1F
GRNB-BK-16
B
1J
GRNC-BK-16
C
RT FRT MODULATOR
1B
YLA-BK-16
A
1D
YLB-BK-16
B
1C
YLC-BK-16
C
LT RR MODULATOR
2D
WHA-BK-16
A
1E
WHB-BK-16
B
2E
WHC-BK-16
C
RT RR MODULATOR
3J
RED1-BK-16
A
3H
RED2-BK-16
B
LT FRT WHEEL SENSOR
2H
GRN1-BK-16
A
3K
GRN2-BK-16
B
RT FRT WHEEL SENSOR
3E
YL1-BK-16
A
2C
YL2-BK-16
B
LT RR WHEEL SENSOR
3D
WH1-BK-16
A
3C
WH2-BK-16
B
RT RR WHEEL SENSOR
3A
DIAGA-BK-16
NOT USED
3B
DIAGB-BK-16
NOT USED
2K
12VA-BK-16
12VA-BK-16
1K
12VA-BK-16
12VA-BK-16
2A
GND-BK-16
1A
GND-BK-16
GND-BK-16
K-1
85
87a
87
86
30
K-2
85
87a
87
86
30
59-BK-18
24V MAS BUS BAR (FRT JBOX)
10A
24VA-BK-16
12VA-BK-16
12VA-BK-16
12VA-BK-16
12VA-BK-16
K-3
6
5
4
3
7
8
1
2
RELAY JAKE BRAKE
6
5
4
3
7
8
1
2
59-BK-18
36-WH-18
12VA-BK-16
SP1-BK-16
15
ENGINE START
55
MASTER RELAY 12V

PART NO.	DESCRIPTION	REV.
7L-13-1174	**TRAILING AXLE**	**C**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

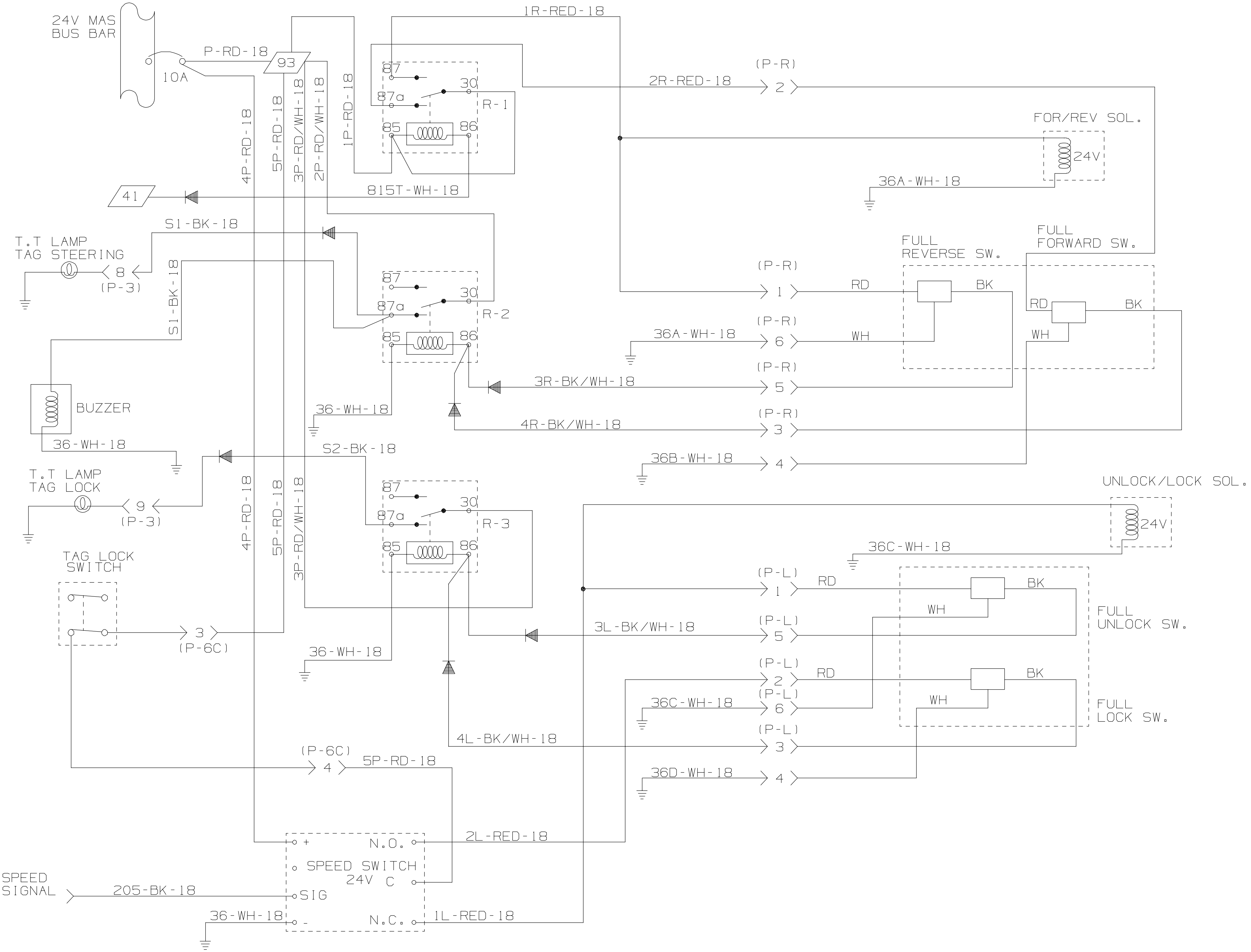
WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

TRAILING AXLE (SELF STEERING)

102DL3

7L-13-1174 (REV C)



24V MAS BUS BAR
10A
P-RD-18
93
1R-RED-18
4P-RD-18
5P-RD-18
3P-RD/WH-18
2P-RD/WH-18
1P-RD-18
87
87a
30
R-1
85
86
(P-R)
2R-RED-18
2
FOR/REV SOL.
24V
36A-WH-18
41
815T-WH-18
S1-BK-18
T.T LAMP TAG STEERING
8
(P-3)
87
87a
30
R-2
85
86
FULL REVERSE SW.
FULL FORWARD SW.
(P-R)
1
RD
BK
RD
BK
(P-R)
36A-WH-18
6
WH
WH
(P-R)
3R-BK/WH-18
5
BUZZER
36-WH-18
(P-R)
4R-BK/WH-18
3
36-WH-18
S2-BK-18
36B-WH-18
4
T.T LAMP TAG LOCK
9
(P-3)
87
87a
30
R-3
85
86
UNLOCK/LOCK SOL.
24V
36C-WH-18
TAG LOCK SWITCH
(P-L)
1
RD
BK
WH
FULL UNLOCK SW.
3
(P-6C)
3L-BK/WH-18
(P-L)
5
36-WH-18
(P-L)
2
RD
BK
36C-WH-18
(P-L)
6
WH
FULL LOCK SW.
4L-BK/WH-18
(P-L)
3
(P-6C)
4
5P-RD-18
36D-WH-18
4
+
N.O.
2L-RED-18
SPEED SWITCH
24V
C
SPEED SIGNAL
205-BK-18
SIG
36-WH-18
-
N.C.
1L-RED-18

PART NO.	DESCRIPTION	REV.
7L-13-1229	KEYED IGNITION	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

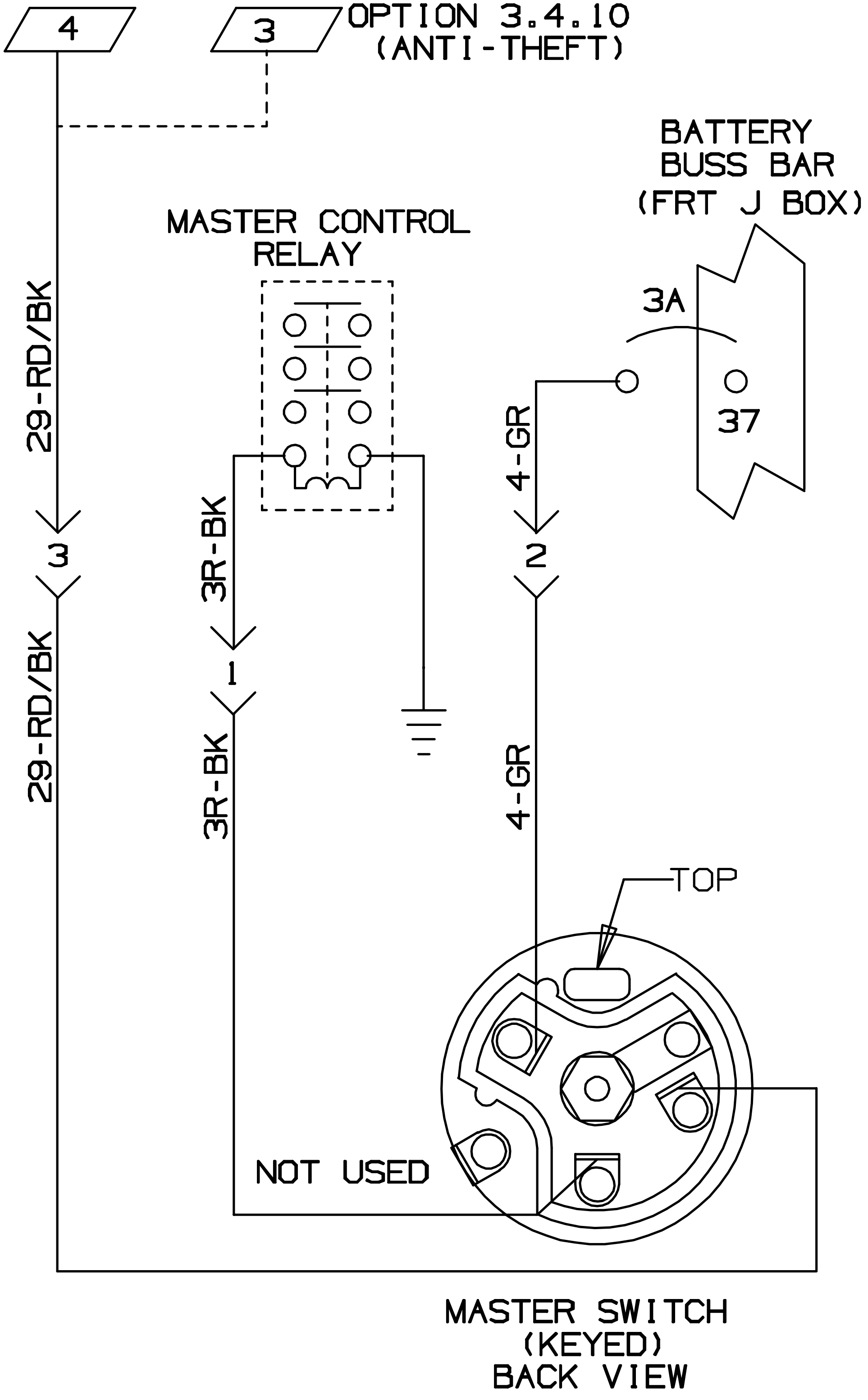
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

KEYED IGNITION
102D3/102DL3
7L-13-1229 (REV A)


4
3
OPTION 3.4.10
(ANTI-THEFT)
BATTERY
BUSS BAR
(FRT J BOX)
MASTER CONTROL
RELAY
3A
37
29-RD/BK
3R-BK
4-GR
3
1
2
29-RD/BK
3R-BK
4-GR
TOP
NOT USED
MASTER SWITCH
(KEYED)
BACK VIEW

PART NO.	DESCRIPTION	REV.
7L-13-1233	TAG AXLE UNLOADING CIRCUIT	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

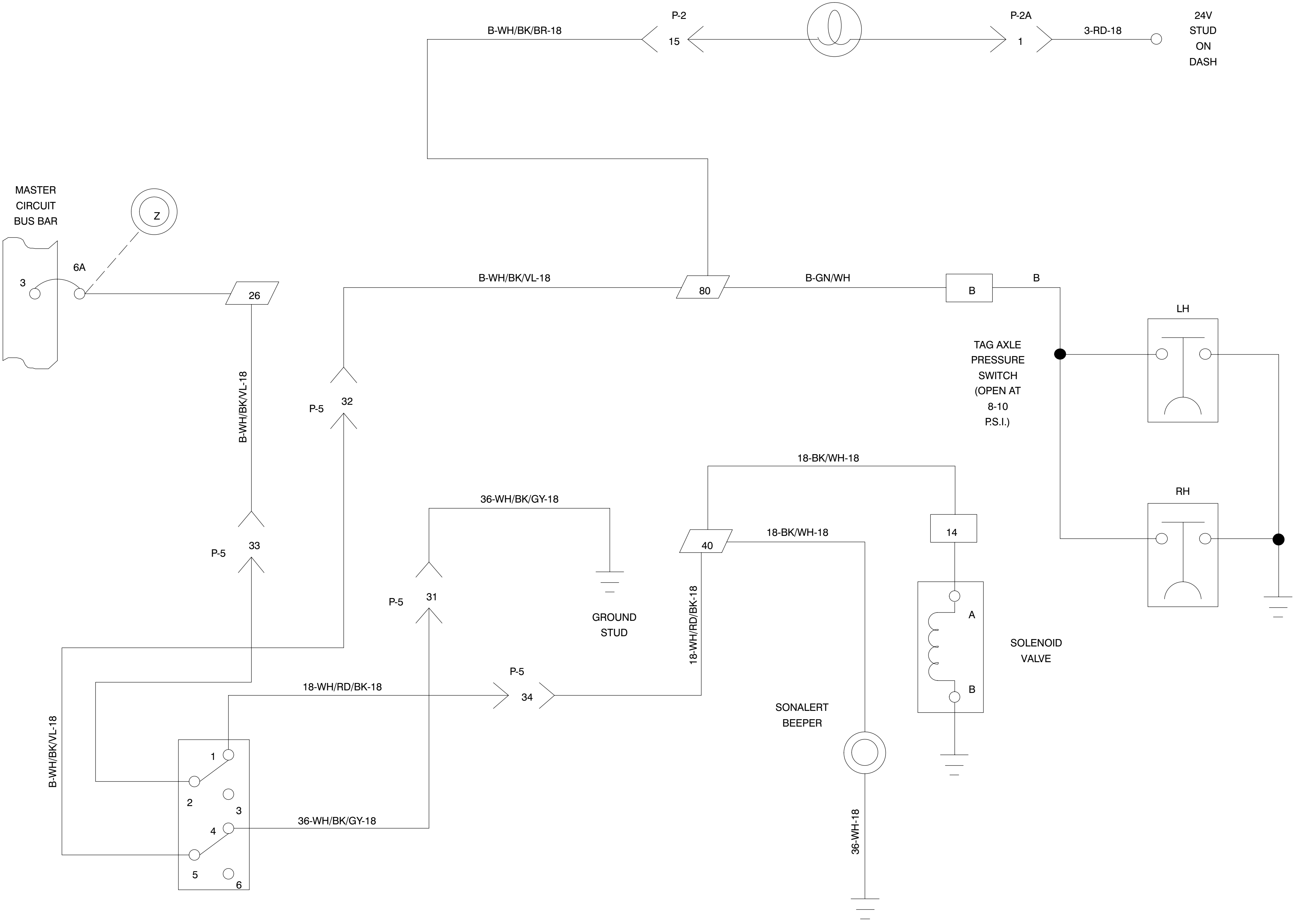
WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

TAG AXLE UNLOADING CIRCUIT

102D3 & 102DL3 MODELS

7L-13-1233 (REV A)


P-2
P-2A
B-WH/BK/BR-18
15
1
3-RD-18
24V
STUD
ON
DASH
MASTER
CIRCUIT
BUS BAR
Z
3
6A
26
B-WH/BK/VL-18
80
B-GN/WH
B
B
LH
RH
TAG AXLE
PRESSURE
SWITCH
(OPEN AT
8-10
P.S.I.)
P-5
32
B-WH/BK/VL-18
P-5
33
18-BK/WH-18
36-WH/BK/GY-18
40
18-BK/WH-18
14
P-5
31
GROUND
STUD
18-WH/RD/BK-18
A
B
SOLENOID
VALVE
P-5
34
18-WH/RD/BK-18
SONALERT
BEEPER
B-WH/BK/VL-18
1
2
3
4
5
6
36-WH/BK/GY-18
36-WH-18

PART NO.	DESCRIPTION	REV.
7L-13-1246	EXTERIOR COACH LIGHTING	C

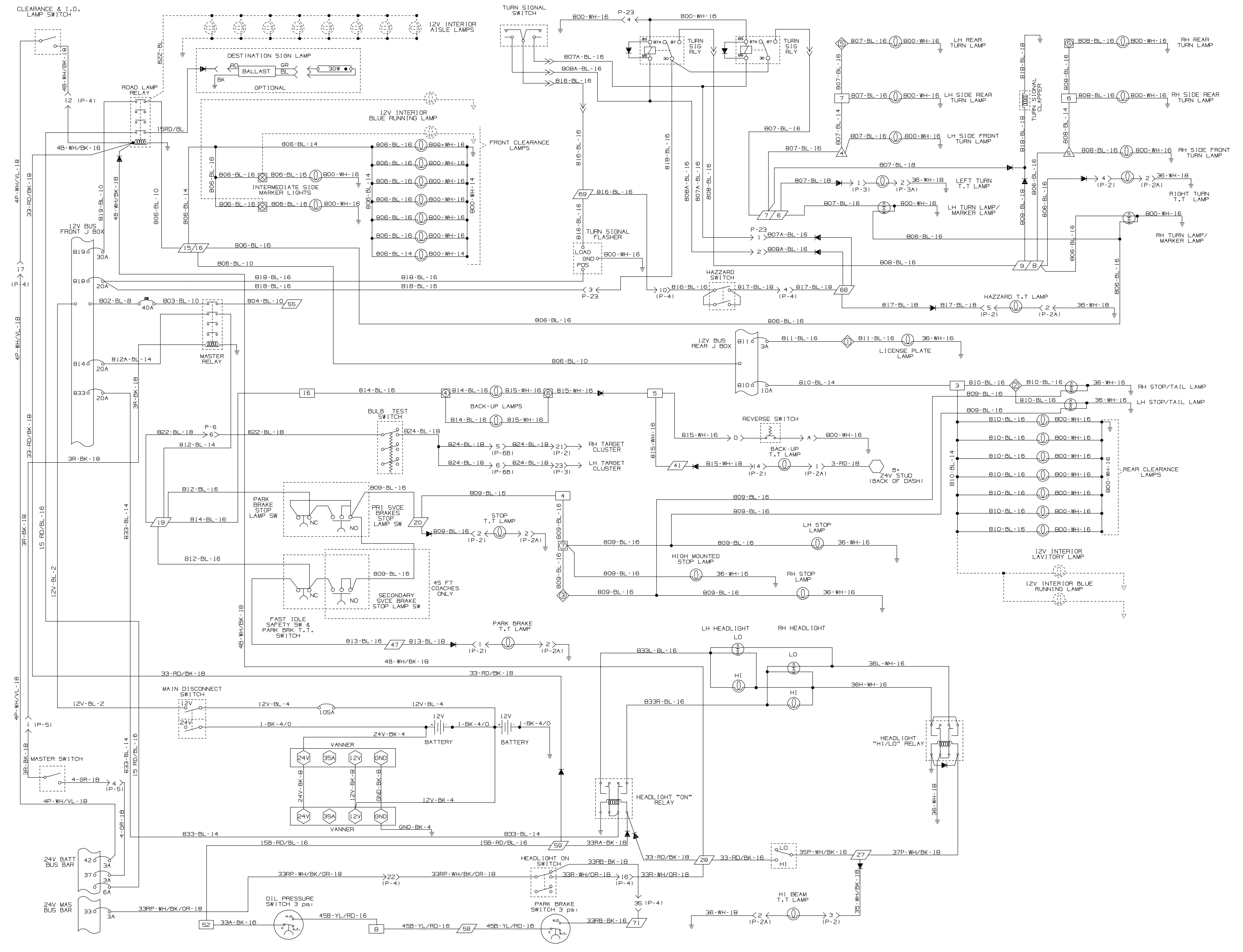
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

EXTERIOR COACH LIGHTING
HEADLAMPS, SIDE MARKER/TURN SIGNAL
102D & 102DL3 (W/DAYTIME RUNNING LIGHTS
7L-13-1246 (REV C)


CLEARANCE & I.D. LAMP SWITCH
12V INTERIOR AISLE LAMPS
DESTINATION SIGN LAMP
BALLAST
RD
GR
BL
BK
30W
OPTIONAL
ROAD LAMP RELAY
15RD/BL
4B-WH/BK-18
12 (P-4)
822-BL
12V INTERIOR BLUE RUNNING LAMP
FRONT CLEARANCE LAMPS
806-BL-14
806-BL-16
800-WH-16
800-WH-14
INTERMEDIATE SIDE MARKER LIGHTS
806-BL-10
819-BL-10
4P-WH/VL-18
33-RD/BK-18
12V BUS FRONT J BOX
819
30A
818
20A
814
833
17
(P-4)
802-BL-8
40A
803-BL-10
804-BL-10
55
MASTER RELAY
818-BL-16
812A-BL-14
3R-BK-18
TURN SIGNAL SWITCH
800-WH-16
P-23
807A-BL-16
808A-BL-16
816-BL-16
TURN SIG RLY
85
87A
87
86
30
69
TURN SIGNAL FLASHER
LOAD
GND
POS
818-BL-16
3
P-23
10
(P-4)
HAZZARD SWITCH
816-BL-16
817-BL-18
4
68
LH REAR TURN LAMP
807-BL-16
LH SIDE REAR TURN LAMP
LH SIDE FRONT TURN LAMP
807-BL-14
TURN SIGNAL CLAPPER
818-BL-18
RH REAR TURN LAMP
808-BL-16
RH SIDE REAR TURN LAMP
RH SIDE FRONT TURN LAMP
808-BL-14
807-BL-18
LEFT TURN T.T LAMP
1 (P-3)
2 (P-3A)
36-WH-18
RIGHT TURN T.T LAMP
4 (P-2)
2 (P-2A)
LH TURN LAMP/ MARKER LAMP
RH TURN LAMP/ MARKER LAMP
7/6
9/8
807A-BL-16
808A-BL-16
HAZZARD T.T LAMP
817-BL-18
5 (P-2)
2 (P-2A)
36-WH-18
806-BL-16
12V BUS REAR J BOX
811
3A
811-BL-16
36-WH-16
LICENSE PLATE LAMP
806-BL-10
810
10A
810-BL-14
3
810-BL-16
RH STOP/TAIL LAMP
LH STOP/TAIL LAMP
809-BL-16
REAR CLEARANCE LAMPS
12V INTERIOR LAVITORY LAMP
12V INTERIOR BLUE RUNNING LAMP
16
814-BL-16
BACK-UP LAMPS
815-WH-16
5
P-6
6
822-BL-18
BULB TEST SWITCH
824-BL-18
5 (P-6B)
21 (P-2)
RH TARGET CLUSTER
6 (P-6B)
23 (P-3)
LH TARGET CLUSTER
812-BL-14
REVERSE SWITCH
D
A
BACK-UP T.T LAMP
41
815-WH-18
14 (P-2)
1 (P-2A)
3-RD-18
B+ 24V STUD (BACK OF DASH)
812-BL-16
PARK BRAKE STOP LAMP SW
NC
NO
PRI SVCE BRAKES STOP LAMP SW
19
20
809-BL-16
STOP T.T LAMP
2 (P-2)
2 (P-2A)
4
7
LH STOP LAMP
HIGH MOUNTED STOP LAMP
RH STOP LAMP
SECONDARY SVCE BRAKE STOP LAMP SW
45 FT COACHES ONLY
FAST IDLE SAFETY SW & PARK BRK T.T. SWITCH
813-BL-16
47
PARK BRAKE T.T LAMP
1 (P-2)
2 (P-2A)
4B-WH/BK-18
LH HEADLIGHT
RH HEADLIGHT
LO
HI
833L-BL-16
36L-WH-16
36H-WH-16
833R-BL-16
HEADLIGHT "HI/LO" RELAY
36-WH-18
33-RD/BK-18
15 RD/BL-16
12V-BL-2
MAIN DISCONNECT SWITCH
12V
24V
12V-BL-4
105A
1-BK-4/0
24V-BK-4
BATTERY
VANNER
24V
35A
GND
24V-BK-8
12V-BK-8
GND-BK-8
12V-BK-4
GND-BK-4
MASTER SWITCH
4-GR-18
4 (P-5I)
1 (P-5I)
4P-WH/VL-18
833-BL-14
HEADLIGHT "ON" RELAY
15B-RD/BL-16
59
33RA-BK-18
24V BATT BUS BAR
42
37
6
3A
24V MAS BUS BAR
33
HEADLIGHT ON SWITCH
33RB-BK-18
33RP-WH/BK/OR-18
22 (P-4)
33R-WH/OR-18
16 (P-4)
28
33-RD/BK-16
35P-WH/BK-16
27
37P-WH/BK-18
35-WH/BK-18
HI BEAM T.T LAMP
2 (P-2A)
3 (P-2)
36-WH-18
35 (P-4)
OIL PRESSURE SWITCH 3 psi
52
33A-BK-16
45B-YL/RD-16
8
58
PARK BRAKE SWITCH 3 psi
33RB-BK-16
71
N.O.
N.C.
C

PART NO.	DESCRIPTION	REV.
7L-13-1281	AIR OPERATED ENTRANCE DOOR	B

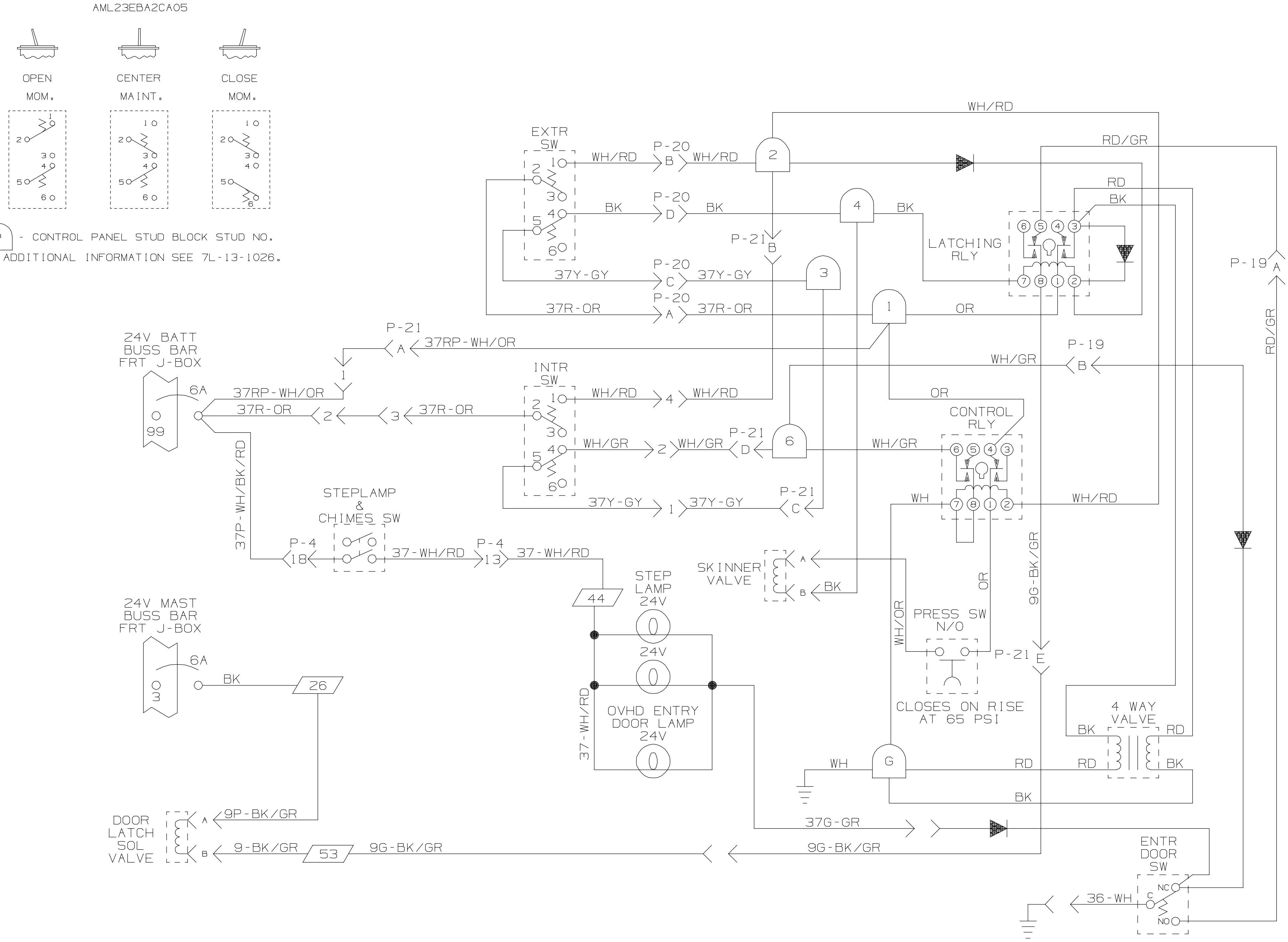
▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱○	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
◘	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE
GR—GREEN

RD—RED
BR—BROWN
BK—BLACK
YL—YELLOW
OR—ORANGE

LEGEND

AIR OPERATED ENTRANCE DOOR
ELECTRICAL CIRCUIT
102D3 & 102DL3 MODELS
7L-13-1281 (REV B)


AML23EBA2CA05
OPEN
MOM.
CENTER
MAINT.
CLOSE
MOM.
1
2
3
4
5
6
EXTR
SW
WH/RD
P-20
B
WH/RD
2
WH/RD
RD/GR
RD
BK
BK
P-20
D
BK
4
BK
P-21
B
LATCHING
RLY
6 5 4 3
7 8 1 2
P-20
C
37Y-GY
37Y-GY
3
P-20
A
37R-OR
37R-OR
1
OR
P-19
A
RD/GR
24V BATT
BUSS BAR
FRT J-BOX
6A
99
P-21
A
37RP-WH/OR
1
37RP-WH/OR
37R-OR
2
3
37R-OR
INTR
SW
WH/RD
4
WH/RD
WH/GR
P-19
B
OR
CONTROL
RLY
WH/GR
2
WH/GR
P-21
D
6
WH/GR
37Y-GY
1
37Y-GY
P-21
C
WH
WH/RD
37P-WH/BK/RD
STEPLAMP
&
CHIMES SW
P-4
18
37-WH/RD
P-4
13
37-WH/RD
44
STEP
LAMP
24V
24V
OVHD ENTRY
DOOR LAMP
24V
37-WH/RD
SKINNER
VALVE
A
B
BK
9G-BK/GR
OR
WH/OR
PRESS SW
N/O
P-21
E
CLOSES ON RISE
AT 65 PSI
24V MAST
BUSS BAR
FRT J-BOX
6A
3
BK
26
4 WAY
VALVE
BK
RD
RD
RD
BK
WH
G
BK
37G-GR
DOOR
LATCH
SOL
VALVE
A
9P-BK/GR
B
9-BK/GR
53
9G-BK/GR
9G-BK/GR
ENTR
DOOR
SW
NC
C
NO
36-WH

NOTE:
1) # - CONTROL PANEL STUD BLOCK STUD NO.
2) FOR ADDITIONAL INFORMATION SEE 7L-13-1026.

PART NO.	DESCRIPTION	REV.
7L-13-1282	AIR OPERATED ENTRANCE DOOR	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE	GR–GREEN	RD–RED
GY–GREY	YL–YELLOW	BR–BROWN
VO–VIOLET	OR–ORANGE	BK–BLACK
BL–BLUE		

LEGEND

OPERATION

1) THE SEDAN DOOR CYLINDER IS A UNIQUE TWO PART CYLINDER. ONE HALF OF THE CYLINDER IS PNEUMATIC WHILE THE OTHER HALF IS HYDRAULIC. THE HYDRAULIC HALF HAS TWO FUNCTIONS.

   A. PROVIDES A HYDRAULIC LOCK.
   B. DAMPENS THE CYLINDER ROD MOVEMENT.

   THE PNEUMATIC HALF MOVES THE CYLINDER ROD. THE HYDRAULIC HALF IS CONTROLLED BY THE SKINNER VALVE AND THE PNEUMATIC HALF IS CONTROLLED BY THE 4 WAY VALVE.

2) TO OPEN THE DOOR EITHER THE INTERNAL OR EXTERNAL SWITCH IS MOVED TO THE OPEN POSITION. THIS ENERGIZES BOTH THE CONTROL AND LATCHING RELAYS. THE LATCHING RELAY SUPPLIES POWER TO THE 4-WAY VALVE PRESSURIZING THE PISTON END OF THE DOOR CYLINDER AND EXHAUSTING THE ROD END OF THE DOOR CYLINDER. THE DOOR LATCH SOLENOID IS INTERRUPTED WHEN THE LATCHING RELAY IS ENERGIZED. THIS EXHAUSTS THE PISTON SIDE OF THE DOOR LATCH CYLINDER RELEASING THE DOOR LATCH. THE SKINNER VALVE REMAINS DE-ENERGIZED DURING THE OPENING SEQUENCE. WITH THE SKINNER VALVE IN THE DE-ENERGIZED STATE THE HYDRAULIC HALF OF THE DOOR CYLINDER ACTS IN THE DAMPING FUNCTION AS THE PILOT OPERATED HYDRAULIC VALVE IS N.O. THE DOOR CONTINUES TO OPEN UNTIL THE SWITCH IS RELEASED OR THE CYLINDER RUNS OUT OF TRAVEL.

3) WHEN THE DOOR IS IN THE OPEN POSITION AND THE DOOR OPEN SWITCH IS RELEASED, THE CONTROL RELAY IS DE-ENERGIZED. THIS ENERGIZES THE SKINNER VALVE PRESSURING THE PILOT PORT OF THE HYDRAULIC VALVE ENABLING THE HYDRAULIC LOCK. THE LATCHING RELAY REMAINS LATCHED WHILE THE DOOR IS OPEN.

4) TO CLOSE THE DOOR EITHER THE INTERNAL OR EXTERNAL SWITCH IS MOVED TO THE CLOSE POSITION. THIS RESETS THE LATCHING RELAY, DE-ENERGIZING THE 4-WAY VALVE WHICH PRESSURIZES THE ROD END AND EXHAUSTS THE PISTON END OF THE DOOR CYLINDER. THE GROUNG CIRCUIT FOR THE SKINNER VALVE IS INTERRUPTED WHEN EITHER THE INTERNAL OR EXTERNAL SWITCH IS IN THE CLOSED POSITION. THIS RELEASES THE HYDRAULIC LOCK AND RETURNS THE HYDRAULIC PART OF THE CYLINDER TO THE DAMPENING MODE. THE DOOR WILL CONTINUE TO CLOSE UNTIL THE SWITCH IS RELEASED OR THE DOOR COMES IN CONTACT WITH THE DOOR JAM. WHEN THE DOOR POSITION SENSING SWITCH SENSES THE DOOR IS CLOSED THE DOOR LATCH SOLENOID IS GROUNDED, PRESSURIZING THE PISTON END OF THE DOOR LATCH CYLINDER WHICH LATCHES THE DOOR CLOSED.

5) IF THE DOOR OPEN/CLOSE SWITCH IS RELEASED DURING EITHER THE OPENING OR CLOSING FUNCTION THE SKINNER VALVE IS GROUNDED PRESSURIZING THE PILOT PORT OF THE HYDRAULIC VALVE WHICH ENABLES THE HYDRAULIC LOCK.

SEDAN DOOR - OPERATION

SWITCHING

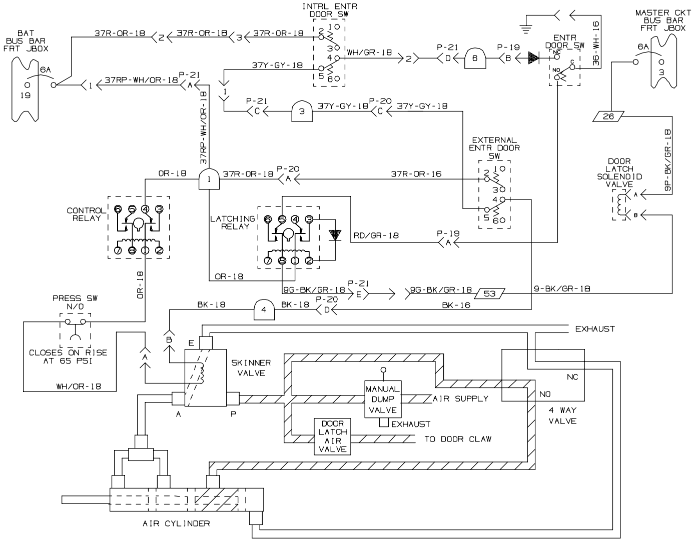
1) INSIDE- DRIVER HOLDS SW FOR DOOR TO OPEN	OUTSIDE SW CAN OVERRIDE DRIVER AND CLOSE DOOR WHILE DRIVER HOLDS HIS SW FOR OPEN
2) INSIDE- DRIVER HOLDS SW FOR CLOSING	OUTSIDE CANNOT OVERRIDE TO OPEN

AIR OPERATED ENTRANCE DOOR
W/PNEUMATIC CIRCUIT (OPEN/CLOSED)
102D3 & 102DL3 MODELS

7L-13-1282 (REV A)

DOOR CLOSED - FUNCTION

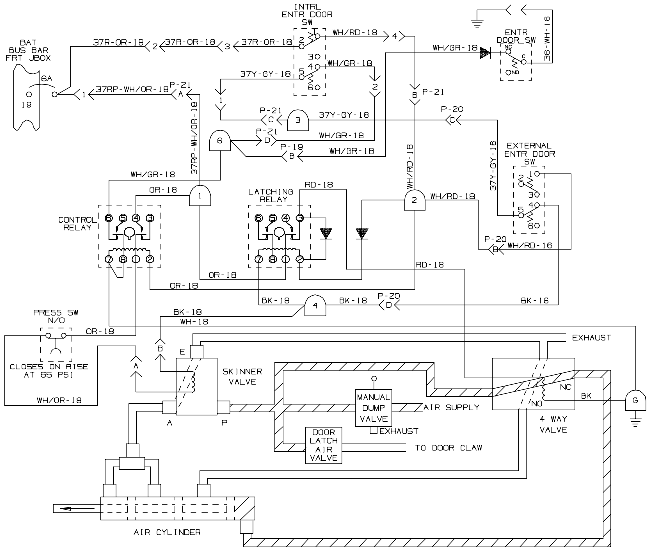
NOTE: BOTH SWITCHES IN CENTER POSITION, DOOR IS CLOSED.



BAT BUS BAR FRT JBOX
19
6A
37R-OR-18
37RP-WH/OR-18
37Y-GY-18
INTRL ENTR DOOR SW
WH/GR-18
P-21
P-19
P-20
ENTR DOOR SW
36-WH-16
MASTER CKT BUS BAR FRT JBOX
26
EXTERNAL ENTR DOOR SW
37R-OR-16
DOOR LATCH SOLENOID VALVE
9P-BK/GR-18
CONTROL RELAY
LATCHING RELAY
RD/GR-18
OR-18
9G-BK/GR-18
53
9-BK/GR-18
BK-18
BK-16
PRESS SW N/O
CLOSES ON RISE AT 65 PSI
WH/OR-18
SKINNER VALVE
EXHAUST
MANUAL DUMP VALVE
AIR SUPPLY
DOOR LATCH AIR VALVE
TO DOOR CLAW
4 WAY VALVE
NC
NO
AIR CYLINDER

DOOR OPENING - FUNCTION

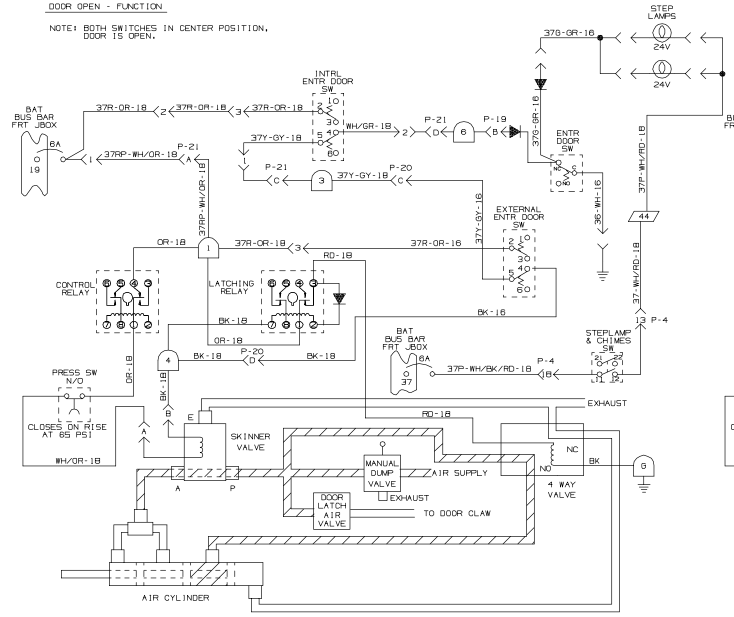
NOTE: INTERNAL SWITCH IN OPEN POSITION & EXTERNAL SWITCH IN CENTER POSITION, DOOR IS OPENING - IN MOTION.



BAT BUS BAR FRT JBOX
19
6A
37R-OR-18
37RP-WH/OR-18
37Y-GY-18
INTRL ENTR DOOR SW
WH/RD-18
WH/GR-18
ENTR DOOR SW
36-WH-16
P-21
P-20
P-19
EXTERNAL ENTR DOOR SW
37Y-GY-16
LATCHING RELAY
RD-18
WH/RD-18
WH/RD-16
CONTROL RELAY
OR-18
RD-18
BK-18
BK-16
WH-18
PRESS SW N/O
CLOSES ON RISE AT 65 PSI
WH/OR-18
SKINNER VALVE
EXHAUST
MANUAL DUMP VALVE
AIR SUPPLY
DOOR LATCH AIR VALVE
TO DOOR CLAW
4 WAY VALVE
NC
NO
BK
G
AIR CYLINDER

DOOR OPEN - FUNCTION

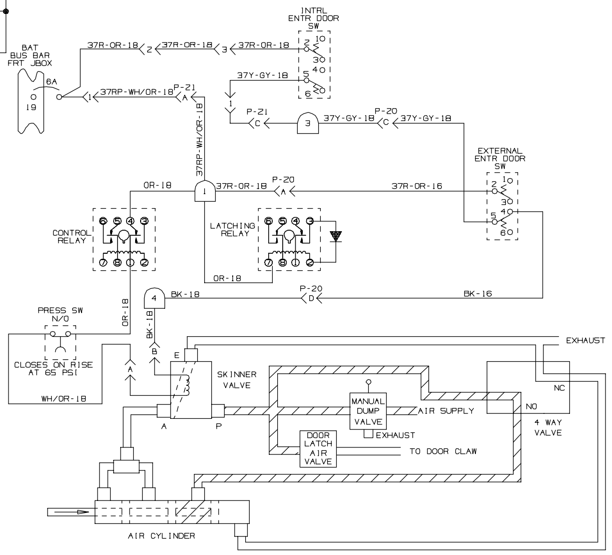
NOTE: BOTH SWITCHES IN CENTER POSITION, DOOR IS OPEN.



STEP LAMPS
24V
24V
37G-GR-16
37G-GR-18
BAT BUS BAR FRT JBOX
19
6A
37R-OR-18
37RP-WH/OR-18
37Y-GY-18
INTRL ENTR DOOR SW
WH/GR-18
P-21
P-19
P-20
ENTR DOOR SW
36-WH-16
37P-WH/RD-18
44
37-WH/RD-18
13 P-4
EXTERNAL ENTR DOOR SW
37Y-GY-16
37R-OR-16
CONTROL RELAY
LATCHING RELAY
RD-18
BK-18
BK-16
OR-18
BAT BUS BAR FRT JBOX
37
37P-WH/BK/RD-18
P-4
STEPLAMP & CHIMES SW
PRESS SW N/O
CLOSES ON RISE AT 65 PSI
WH/OR-18
BK-18
SKINNER VALVE
EXHAUST
MANUAL DUMP VALVE
AIR SUPPLY
DOOR LATCH AIR VALVE
TO DOOR CLAW
4 WAY VALVE
NC
NO
BK
G
AIR CYLINDER

DOOR CLOSING - FUNCTION

NOTE: INTERNAL SWITCH IN CLOSED POSITION & EXTERNAL SWITCH IN CENTER POSITION, DOOR IS CLOSING - IN MOTION.



BAT BUS BAR FRT JBOX
19
6A
37R-OR-18
37RP-WH/OR-18
37Y-GY-18
INTRL ENTR DOOR SW
P-21
P-20
EXTERNAL ENTR DOOR SW
37R-OR-16
CONTROL RELAY
LATCHING RELAY
OR-18
BK-18
BK-16
PRESS SW N/O
CLOSES ON RISE AT 65 PSI
WH/OR-18
SKINNER VALVE
EXHAUST
MANUAL DUMP VALVE
AIR SUPPLY
DOOR LATCH AIR VALVE
TO DOOR CLAW
4 WAY VALVE
NC
NO
AIR CYLINDER

1) # - CONTROL PANEL STUD BLOCK STUD NO.

2) ▨ - AIR PRESSURE

PART NO.	DESCRIPTION	REV.
7L-13-1286	ENGINE COOLANT RECOVERY	

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⧈	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

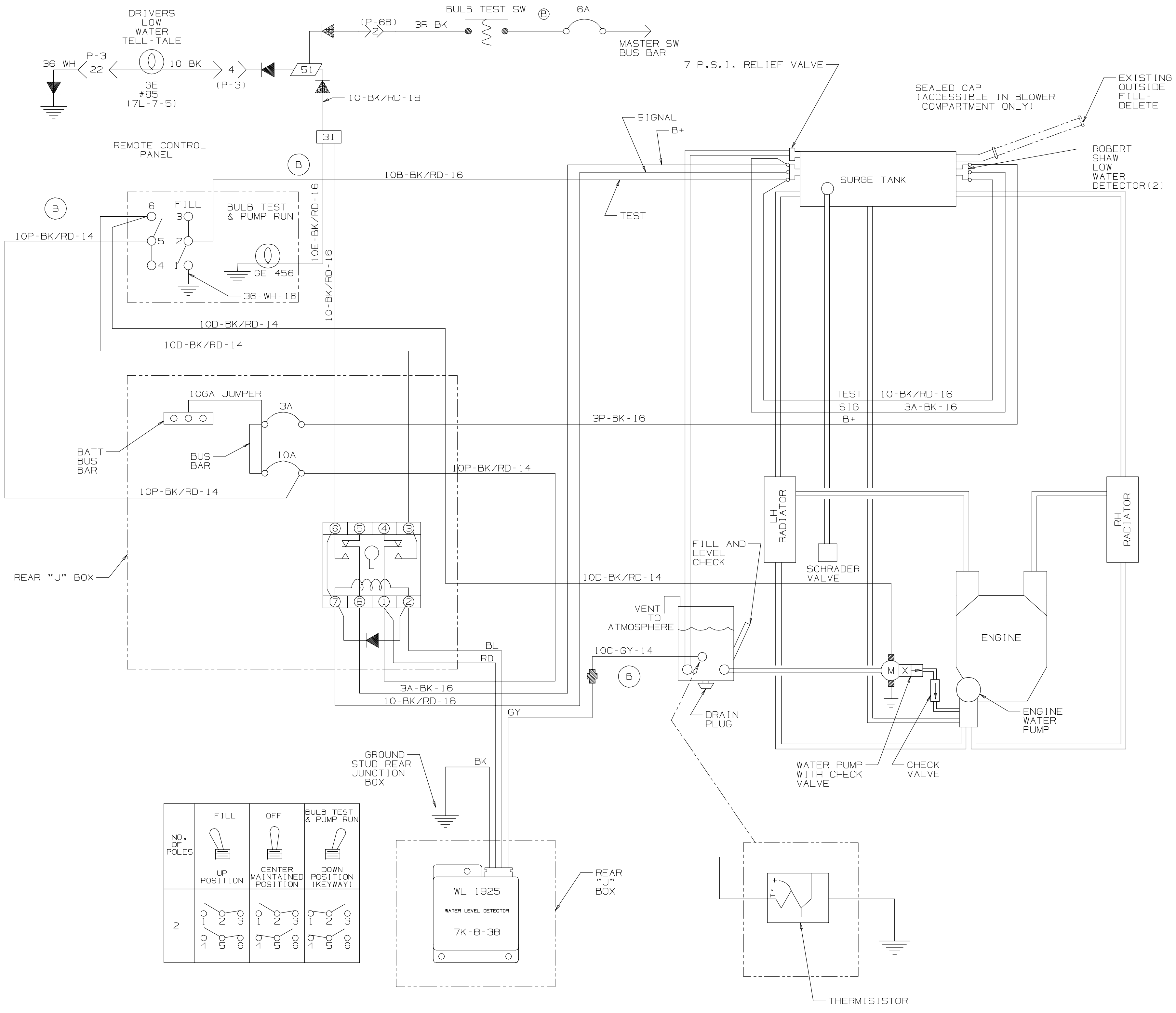
WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

ENGINE COOLANT RECOVERY

102D3 & 102DL3

7L-13-1286 (REV C)



DRIVERS LOW WATER TELL-TALE
36 WH
P-3
22
10 BK
4
(P-3)
GE #85 (7L-7-5)
51
10-BK/RD-18
(P-6B)
2
3R BK
BULB TEST SW
Ⓑ
6A
MASTER SW BUS BAR
7 P.S.I. RELIEF VALVE
SEALED CAP (ACCESSIBLE IN BLOWER COMPARTMENT ONLY)
EXISTING OUTSIDE FILL-DELETE
SIGNAL
B+
31
REMOTE CONTROL PANEL
B
10B-BK/RD-16
TEST
SURGE TANK
ROBERT SHAW LOW WATER DETECTOR(2)
B
6
FILL
3
BULB TEST & PUMP RUN
10P-BK/RD-14
5
2
4
1
GE 456
10E-BK/RD-16
10-BK/RD-16
36-WH-16
10D-BK/RD-14
10D-BK/RD-14
10GA JUMPER
3A
BATT BUS BAR
BUS BAR
10A
3P-BK-16
TEST
10-BK/RD-16
SIG
3A-BK-16
B+
10P-BK/RD-14
10P-BK/RD-14
REAR "J" BOX
6
5
4
3
7
8
1
2
10D-BK/RD-14
LH RADIATOR
RH RADIATOR
FILL AND LEVEL CHECK
SCHRADER VALVE
VENT TO ATMOSPHERE
ENGINE
BL
RD
10C-GY-14
B
M
X
3A-BK-16
10-BK/RD-16
DRAIN PLUG
ENGINE WATER PUMP
GY
GROUND STUD REAR JUNCTION BOX
BK
WATER PUMP WITH CHECK VALVE
CHECK VALVE
NO. OF POLES
FILL
OFF
BULB TEST & PUMP RUN
UP POSITION
CENTER MAINTAINED POSITION
DOWN POSITION (KEYWAY)
2
1 2 3
4 5 6
1 2 3
4 5 6
1 2 3
4 5 6
WL-1925
WATER LEVEL DETECTOR
7K-8-38
REAR "J" BOX
T°
THERMISISTOR

PART NO.	DESCRIPTION	REV.
7L-13-1336	RETRACTABLE STEP	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

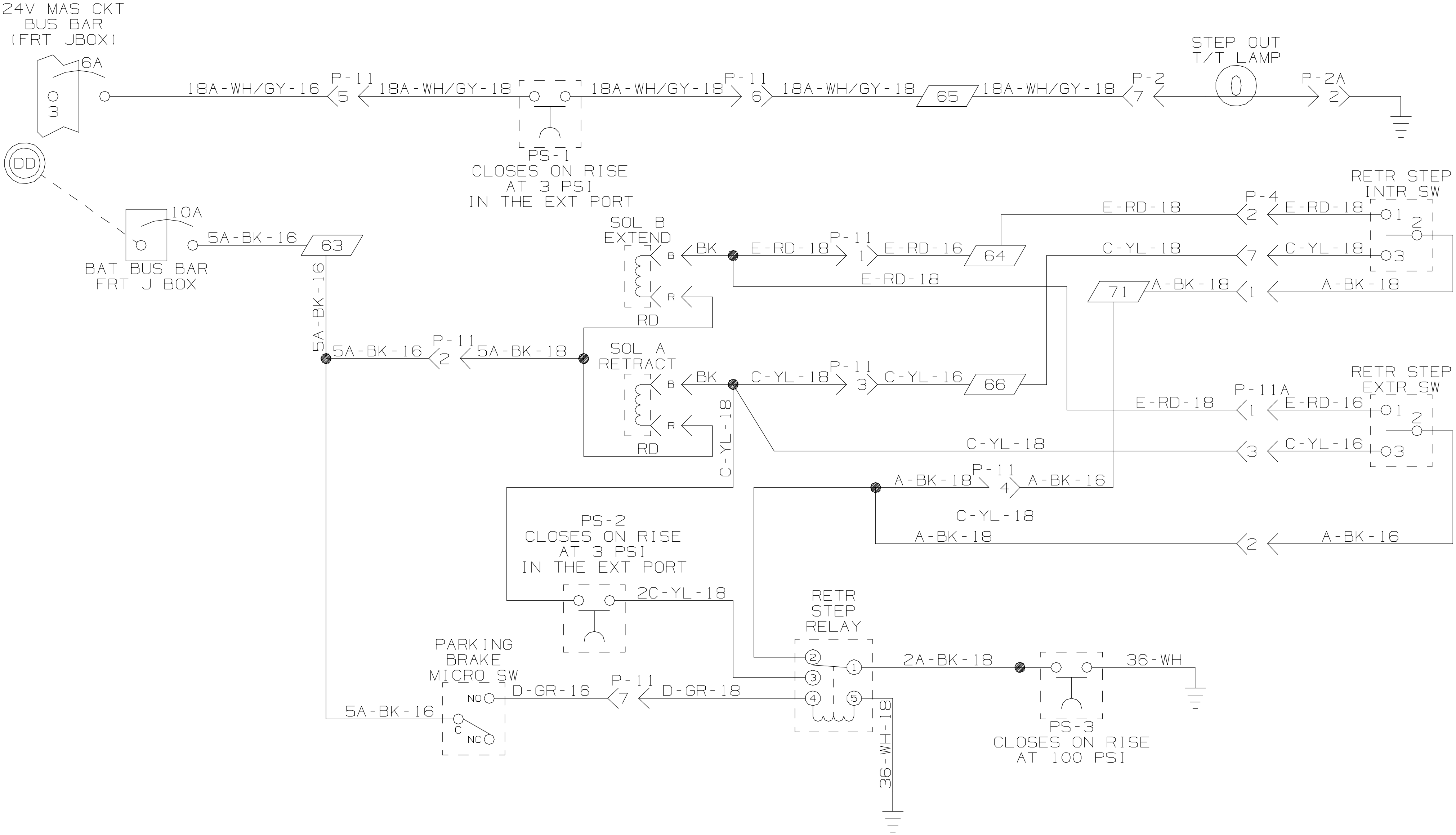
WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

RETRACTABLE STEP

102D3 & 102DL3

7L-13-1336 (REV B)


24V MAS CKT
BUS BAR
(FRT JBOX)
6A
3
DD
18A-WH/GY-16
P-11
5
18A-WH/GY-18
PS-1
CLOSES ON RISE
AT 3 PSI
IN THE EXT PORT
18A-WH/GY-18
P-11
6
18A-WH/GY-18
65
18A-WH/GY-18
P-2
7
STEP OUT
T/T LAMP
P-2A
2
10A
BAT BUS BAR
FRT J BOX
5A-BK-16
63
5A-BK-16
SOL B
EXTEND
B
R
BK
E-RD-18
P-11
1
E-RD-16
64
E-RD-18
RD
E-RD-18
P-4
2
E-RD-18
RETR STEP
INTR SW
1
2
3
C-YL-18
7
C-YL-18
71
A-BK-18
1
A-BK-18
5A-BK-16
P-11
2
5A-BK-18
SOL A
RETRACT
B
R
BK
C-YL-18
P-11
3
C-YL-16
66
RD
C-YL-18
RETR STEP
EXTR SW
P-11A
E-RD-18
1
E-RD-16
C-YL-18
3
C-YL-16
A-BK-18
P-11
4
A-BK-16
C-YL-18
A-BK-18
2
A-BK-16
PS-2
CLOSES ON RISE
AT 3 PSI
IN THE EXT PORT
2C-YL-18
RETR
STEP
RELAY
2
1
3
4
5
2A-BK-18
36-WH
PS-3
CLOSES ON RISE
AT 100 PSI
36-WH-18
PARKING
BRAKE
MICRO SW
NO
C
NC
5A-BK-16
D-GR-16
P-11
7
D-GR-18

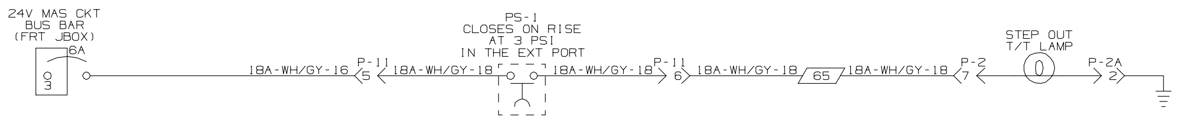
PART NO.	DESCRIPTION	REV.
7L-13-1337	RETRACTABLE STEP	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⧗	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

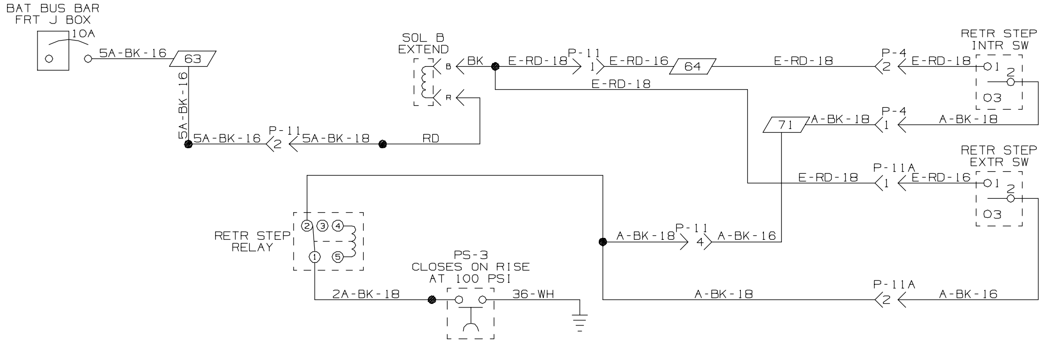
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
YL–YELLOW
OR–ORANGE
RD–RED
BR–BROWN
BK–BLACK

LEGEND

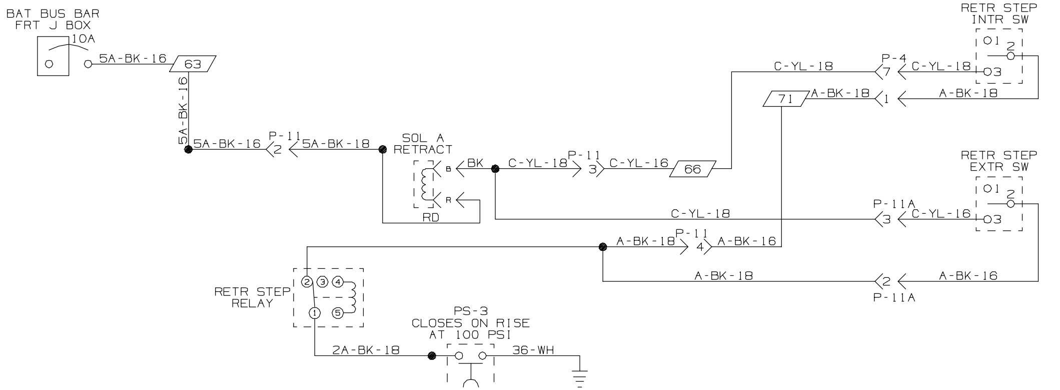
RETRACTABLE STEP
102D3 & 102DL3
7L-13-1337 (REV B)


24V MAS CKT
BUS BAR
(FRT JBOX)
6A
3
18A-WH/GY-16
P-11
5
PS-1
CLOSES ON RISE
AT 3 PSI
IN THE EXT PORT
18A-WH/GY-18
18A-WH/GY-18
P-11
6
18A-WH/GY-18
65
18A-WH/GY-18
P-2
7
STEP OUT
T/T LAMP
P-2A
2

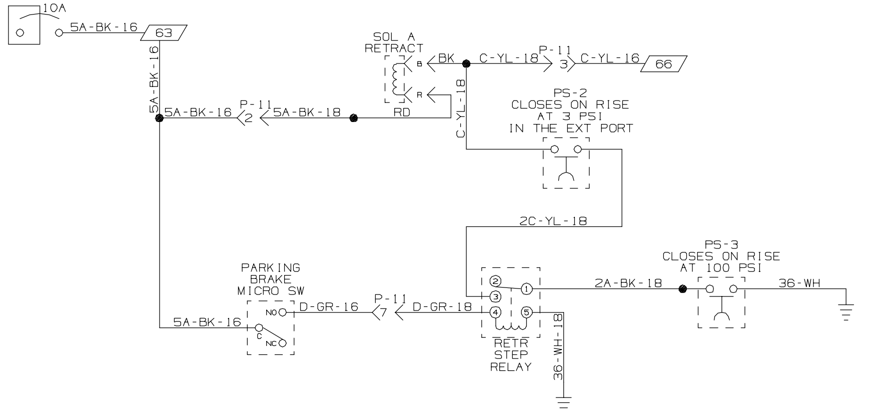
INDICATOR LIGHT CIRCUIT


BAT BUS BAR
FRT J BOX
10A
5A-BK-16
63
5A-BK-16
5A-BK-16
P-11
2
5A-BK-18
RD
SOL B
EXTEND
B
R
BK
E-RD-18
P-11
1
E-RD-16
64
E-RD-18
P-4
2
E-RD-18
RETR STEP
INTR SW
1
2
3
E-RD-18
71
A-BK-18
P-4
1
A-BK-18
RETR STEP
EXTR SW
E-RD-18
P-11A
1
E-RD-16
RETR STEP
RELAY
2
3
4
1
5
A-BK-18
P-11
4
A-BK-16
PS-3
CLOSES ON RISE
AT 100 PSI
2A-BK-18
36-WH
A-BK-18
P-11A
2
A-BK-16

STEP EXTEND CIRCUIT


BAT BUS BAR
FRT J BOX
10A
5A-BK-16
63
5A-BK-16
5A-BK-16
P-11
2
5A-BK-18
SOL A
RETRACT
B
R
RD
BK
C-YL-18
P-11
3
C-YL-16
66
RETR STEP
INTR SW
1
2
3
C-YL-18
P-4
7
C-YL-18
71
A-BK-18
1
A-BK-18
RETR STEP
EXTR SW
C-YL-18
P-11A
3
C-YL-16
A-BK-18
P-11
4
A-BK-16
A-BK-18
2
P-11A
A-BK-16
RETR STEP
RELAY
2
3
4
1
5
PS-3
CLOSES ON RISE
AT 100 PSI
2A-BK-18
36-WH

NORMAL STEP RETRACT CIRCUIT


10A
5A-BK-16
63
5A-BK-16
5A-BK-16
P-11
2
5A-BK-18
RD
SOL A
RETRACT
B
R
BK
C-YL-18
P-11
3
C-YL-16
66
C-YL-18
PS-2
CLOSES ON RISE
AT 3 PSI
IN THE EXT PORT
2C-YL-18
PARKING
BRAKE
MICRO SW
NO
C
NC
5A-BK-16
D-GR-16
P-11
7
D-GR-18
2
3
4
1
5
RETR
STEP
RELAY
36-WH-18
PS-3
CLOSES ON RISE
AT 100 PSI
2A-BK-18
36-WH

RELEASE PARKING BRAKE RETRACTING STEP

PART NO.	DESCRIPTION	REV.
7L-13-1387	INTERIOR LIGHTING 102DLS	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

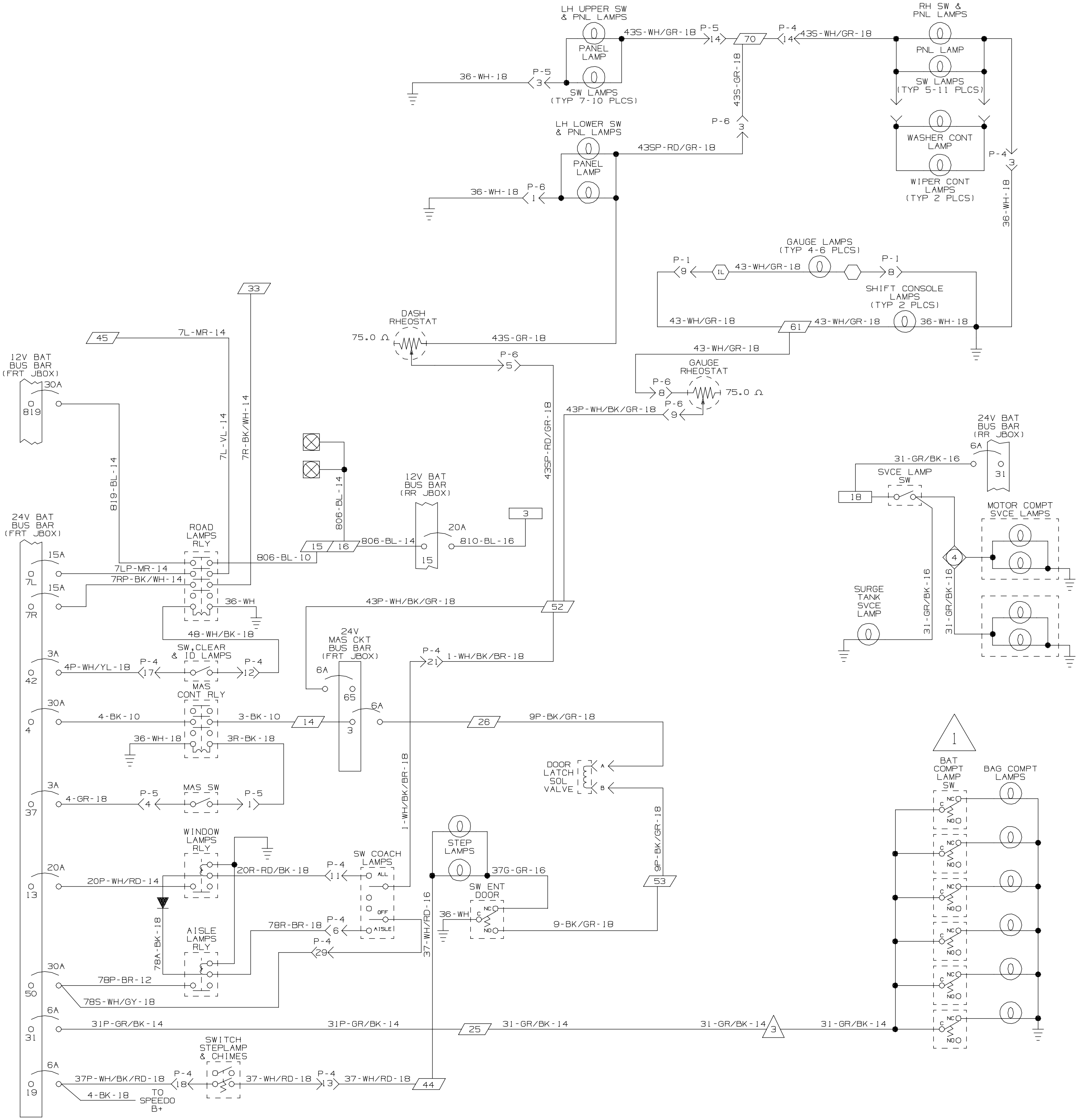
RD–RED
BR–BROWN
BK–BLACK

LEGEND

LIGHTING - INTERIOR

102DL3 CONVERSION COACH

7L-13-1387 (REV A)



LH UPPER SW & PNL LAMPS
PANEL LAMP
SW LAMPS (TYP 7-10 PLCS)
43S-WH/GR-18
P-5
14
70
P-4
14
43S-WH/GR-18
RH SW & PNL LAMPS
PNL LAMP
SW LAMPS (TYP 5-11 PLCS)
WASHER CONT LAMP
WIPER CONT LAMPS (TYP 2 PLCS)
36-WH-18
P-5
3
43S-GR-18
P-6
3
LH LOWER SW & PNL LAMPS
PANEL LAMP
43SP-RD/GR-18
36-WH-18
P-6
1
P-4
3
36-WH-18
GAUGE LAMPS (TYP 4-6 PLCS)
P-1
9
IL
43-WH/GR-18
P-1
8
SHIFT CONSOLE LAMPS (TYP 2 PLCS)
43-WH/GR-18
61
43-WH/GR-18
36-WH-18
33
45
7L-MR-14
DASH RHEOSTAT
75.0 Ω
43S-GR-18
P-6
5
43-WH/GR-18
GAUGE RHEOSTAT
P-6
8
75.0 Ω
43P-WH/BK/GR-18
P-6
9
43SP-RD/GR-18
12V BAT BUS BAR (FRT JBOX)
30A
819
819-BL-14
7L-VL-14
7R-BK/WH-14
806-BL-14
12V BAT BUS BAR (RR JBOX)
20A
15
810-BL-16
3
15
16
806-BL-14
806-BL-10
24V BAT BUS BAR (RR JBOX)
6A
31
31-GR/BK-16
SVCE LAMP SW
18
MOTOR COMPT SVCE LAMPS
4
SURGE TANK SVCE LAMP
31-GR/BK-16
31-GR/BK-16
24V BAT BUS BAR (FRT JBOX)
ROAD LAMPS RLY
15A
7L
7LP-MR-14
15A
7R
7RP-BK/WH-14
36-WH
43P-WH/BK/GR-18
52
48-WH/BK-18
24V MAS CKT BUS BAR (FRT JBOX)
6A
65
3A
42
4P-WH/YL-18
P-4
17
SW,CLEAR & ID LAMPS
P-4
12
P-4
21
1-WH/BK/BR-18
MAS CONT RLY
30A
4
4-BK-10
3-BK-10
14
6A
3
26
9P-BK/GR-18
36-WH-18
3R-BK-18
DOOR LATCH SOL VALVE
A
B
1
3A
37
4-GR-18
P-5
4
MAS SW
P-5
1
1-WH/BK/BR-18
9P-BK/GR-18
BAT COMPT LAMP SW
BAG COMPT LAMPS
C
NC
NO
WINDOW LAMPS RLY
20A
13
20P-WH/RD-14
20R-RD/BK-18
P-4
11
SW COACH LAMPS
ALL
OFF
AISLE
STEP LAMPS
37G-GR-16
SW ENT DOOR
NC
C
NO
36-WH
9-BK/GR-18
53
78A-BK-18
AISLE LAMPS RLY
78R-BR-18
P-4
6
P-4
29
37-WH/RD-16
30A
50
78P-BR-12
78S-WH/GY-18
6A
31
31P-GR/BK-14
31P-GR/BK-14
25
31-GR/BK-14
31-GR/BK-14
3
31-GR/BK-14
SWITCH STEPLAMP & CHIMES
6A
19
37P-WH/BK/RD-18
P-4
18
37-WH/RD-18
P-4
13
37-WH/RD-18
44
4-BK-18
TO SPEEDO B+

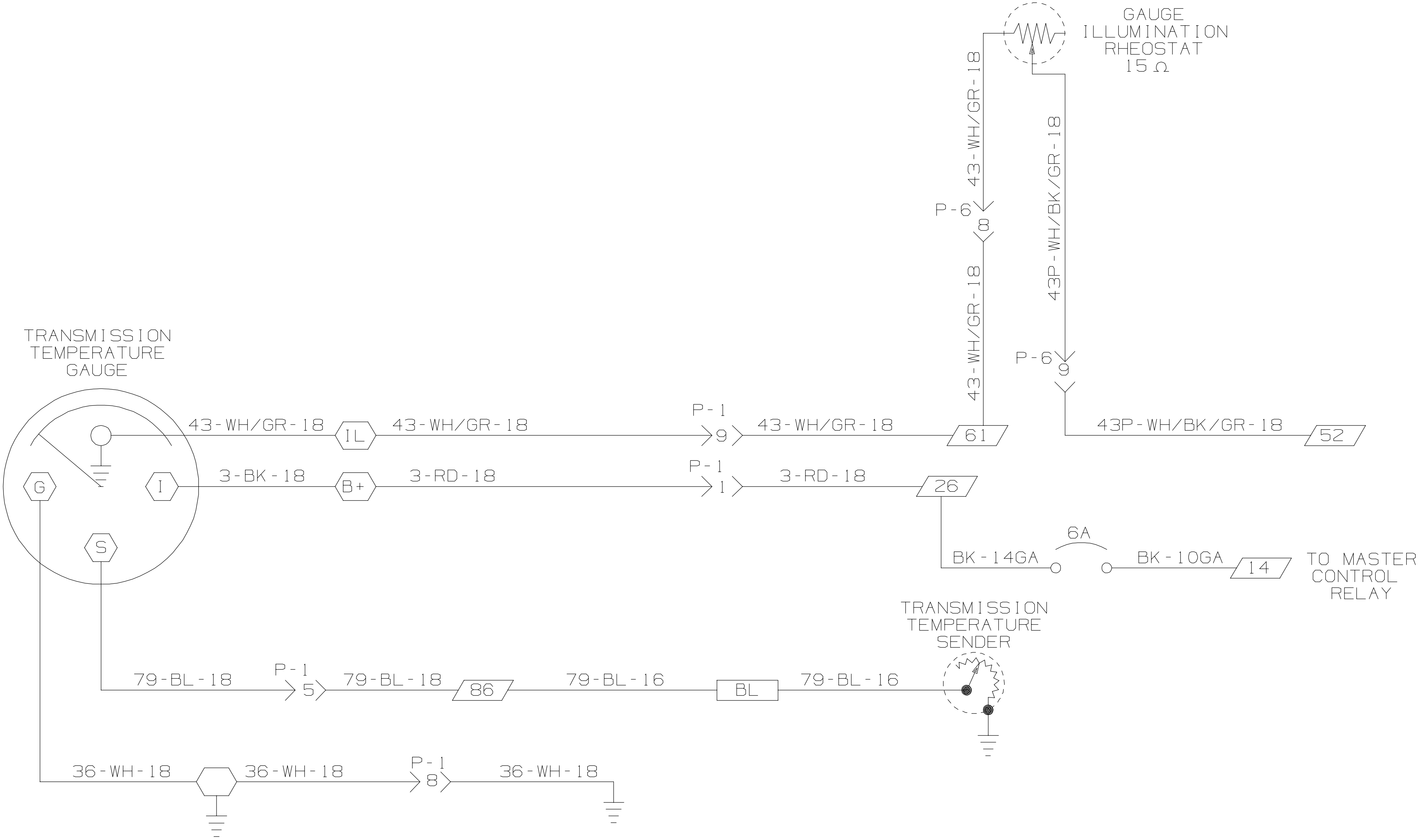
PART NO.	DESCRIPTION	REV.
7L-13-1446	TRANSMISSION OIL TEMP	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE	GR–GREEN	RD–RED
GY–GREY	YL–YELLOW	BR–BROWN
VO–VIOLET	OR–ORANGE	BK–BLACK
BL–BLUE		

LEGEND

TRANSMISSION OIL TEMPERATURE
102D3/102DL3
7L-13-1446 (REV A)


GAUGE ILLUMINATION RHEOSTAT 15 Ω
43-WH/GR-18
43P-WH/BK/GR-18
P-6
8
43-WH/GR-18
P-6
9
TRANSMISSION TEMPERATURE GAUGE
43-WH/GR-18
IL
43-WH/GR-18
P-1
9
43-WH/GR-18
61
43P-WH/BK/GR-18
52
G
I
S
3-BK-18
B+
3-RD-18
P-1
1
3-RD-18
26
6A
BK-14GA
BK-10GA
14
TO MASTER CONTROL RELAY
TRANSMISSION TEMPERATURE SENDER
79-BL-18
P-1
5
79-BL-18
86
79-BL-16
BL
79-BL-16
36-WH-18
36-WH-18
P-1
8
36-WH-18

PART NO.	DESCRIPTION	REV.
7L-13-1580	**ENGINE INSTALLATION SERIES 60 DDEC**	**J**

▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱○	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

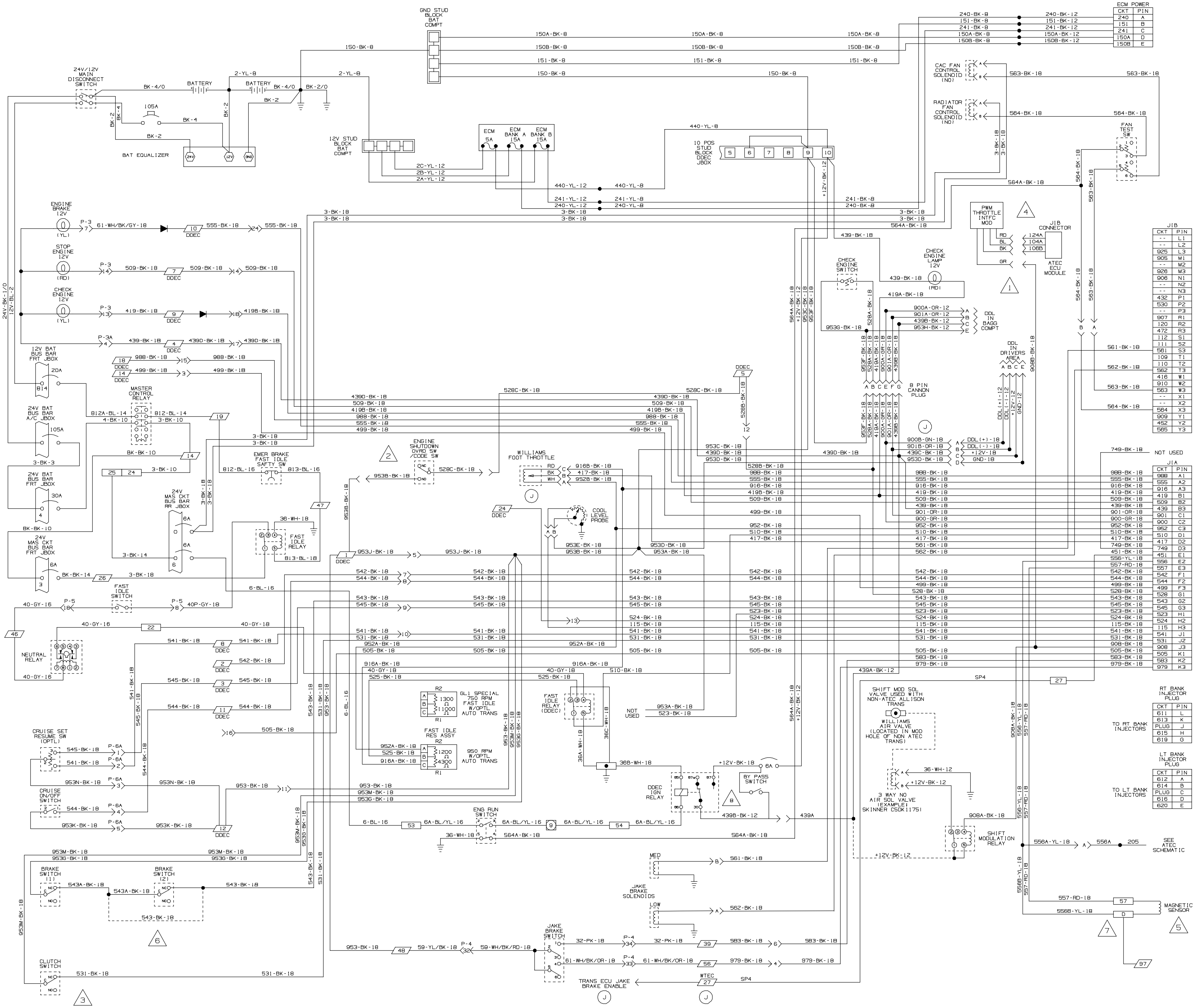
WH—WHITE	RD—RED
GY—GREY	BR—BROWN
VO—VIOLET	BK—BLACK
BL—BLUE	YL—YELLOW
GR—GREEN	OR—ORANGE

LEGEND

INSTALLATION OF ELECTRONICALLY CONTROLLED DETROIT DIESEL (DDEC) ENGINE

102D & 102DL MODELS

7L—13—1580 (REV J)


GND STUD BLOCK BAT COMPT
24V/12V MAIN DISCONNECT SWITCH
BATTERY
BATTERY
105A
BAT EQUALIZER
24V
12V
GND
12V STUD BLOCK BAT COMPT
ECM 5A
ECM BANK A 15A
ECM BANK B 15A
10 POS STUD BLOCK DDEC JBOX
CAC FAN CONTROL SOLENOID (NO)
RADIATOR FAN CONTROL SOLENOID (NO)
FAN TEST SW
PWM THROTTLE INTFC MOD
J1B CONNECTOR
ATEC ECU MODULE
ENGINE BRAKE 12V (YL)
STOP ENGINE 12V (RD)
CHECK ENGINE 12V (YL)
12V BAT BUS BAR FRT JBOX
24V BAT BUS BAR A/C JBOX
24V BAT BUS BAR FRT JBOX
24V MAS CKT BUS BAR RR JBOX
24V MAS CKT BUS BAR FRT JBOX
MASTER CONTROL RELAY
EMER BRAKE FAST IDLE SAFTY SW
FAST IDLE RELAY
ENGINE SHUTDOWN OVRD SW /CODE SW
WILLIAMS FOOT THROTTLE
COOL LEVEL PROBE
CHECK ENGINE SWITCH
CHECK ENGINE LAMP 12V (RD)
DDL IN BAGG COMPT
DDL IN DRIVERS AREA
8 PIN CANNON PLUG
FAST IDLE SWITCH
NEUTRAL RELAY
GL1 SPECIAL 750 RPM FAST IDLE W/OPTL AUTO TRANS
FAST IDLE RES ASSY
950 RPM W/OPTL AUTO TRANS
R1 R2 1300 Ω 11000 Ω 1200 Ω 4300 Ω
FAST IDLE RELAY (DDEC)
NOT USED
DDEC IGN RELAY
BY PASS SWITCH
ENG RUN SWITCH
CRUISE SET RESUME SW (OPTL)
CRUISE ON/OFF SWITCH
BRAKE SWITCH (1)
BRAKE SWITCH (2)
CLUTCH SWITCH
SHIFT MOD SOL VALVE USED WITH NON-ATEC ALLISON TRANS
WILLIAMS AIR VALVE (LOCATED IN MOD HOLE OF NON ATEC TRANS)
3 WAY NO AIR SOL VALVE (EXAMPLE: SKINNER C5DK1175)
SHIFT MODULATION RELAY
MED
LOW
JAKE BRAKE SOLENOIDS
JAKE BRAKE SWITCH
TRANS ECU JAKE BRAKE ENABLE
WTEC
MAGNETIC SENSOR
SEE ATEC SCHEMATIC
TO RT BANK INJECTORS
TO LT BANK INJECTORS
NOT USED
1 2 3 4 5 6 7 8 9 J

ECM POWER

CKT	PIN
240	A
151	B
241	C
150A	D
150B	E

J1B

CKT	PIN
--	L1
--	L2
925	L3
905	M1
--	M2
926	M3
906	N1
--	N2
--	N3
432	P1
530	P2
--	P3
907	R1
120	R2
472	R3
112	S1
111	S2
561	S3
109	T1
110	T2
562	T3
416	W1
910	W2
563	W3
--	X1
--	X2
564	X3
909	Y1
452	Y2
565	Y3

J1A

CKT	PIN
988	A1
555	A2
916	A3
419	B1
509	B2
439	B3
901	C1
900	C2
952	C3
510	D1
417	D2
749	D3
451	E1
556	E2
557	E3
542	F1
544	F2
499	F3
528	G1
543	G2
545	G3
523	H1
524	H2
115	H3
541	J1
531	J2
908	J3
505	K1
583	K2
979	K3

RT BANK INJECTOR PLUG

CKT	PIN
611	L
613	K
PLUG	J
615	H
619	G

LT BANK INJECTOR PLUG

CKT	PIN
612	A
614	B
PLUG	C
616	D
620	E

PART NO.	DESCRIPTION	REV.
7L-13-1607	DECAL INSTALLATION A/C J-BOX	

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⧖	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
YL–YELLOW
OR–ORANGE
RD–RED
BR–BROWN
BK–BLACK

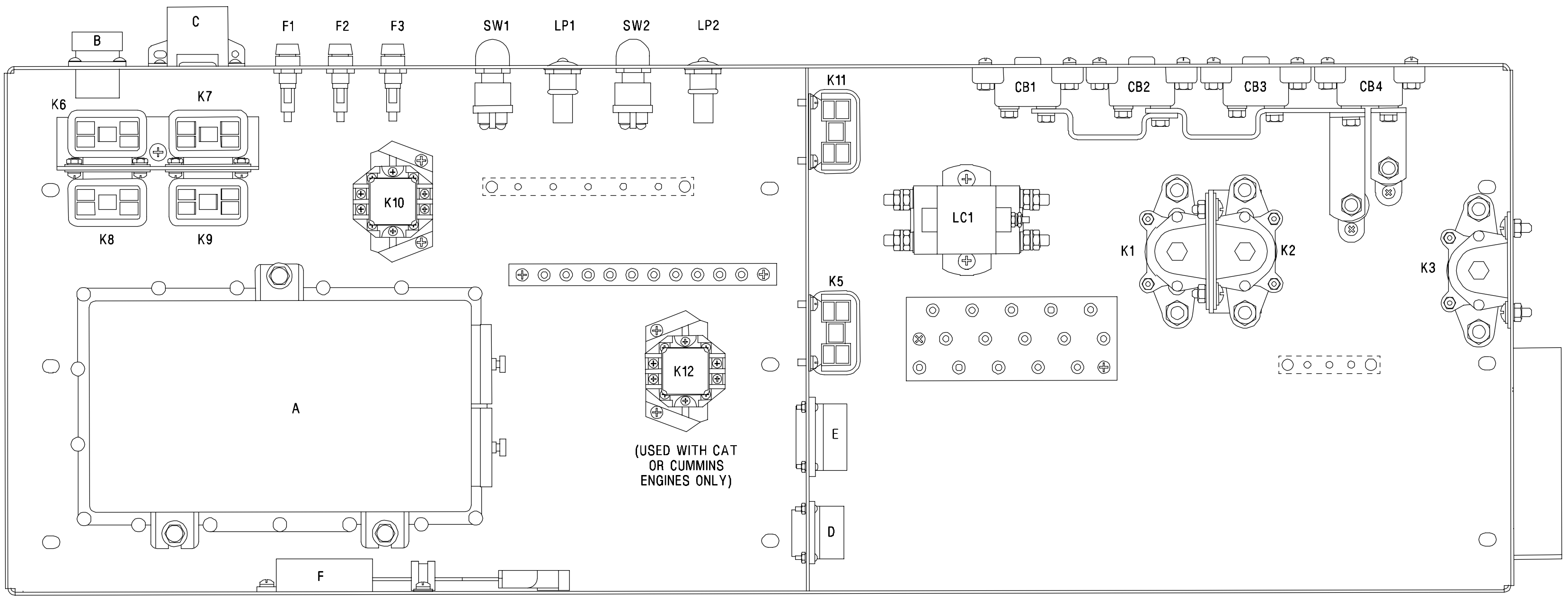
LEGEND

DECAL INSTALLATION

A/C JUNCTION BOX W/DDEC/ATEC DIAGNOSTIC PORT

102D & 102DL3

7L-13-1607 (REV B)


B
C
F1
F2
F3
SW1
LP1
SW2
LP2
K6
K7
K8
K9
K10
K11
CB1
CB2
CB3
CB4
LC1
K1
K2
K3
K5
A
K12
E
D
F

(USED WITH CAT
OR CUMMINS
ENGINES ONLY)

A) ECU (OPT)
B) DDEC DIAGNOSTIC PLUG
C) ATEC DIAGNOSTIC PLUG (OPT)
D) DDEC PLUG
E) ATEC PLUG (OPT)
F) PWM MOD (OPT)

CB1) 105 AMP CNDSR MTR
CB2) 105 AMP CNDSR MTR
CB3) 105 AMP EVAP MTR
CB4) 105 AMP MAIN BRKR

F1) 8 AMP ATEC (OPT)
F2) 5 AMP ATEC (OPT)
F3) 8 AMP ATEC (OPT)

K1) 1ST CNDSR MTR RLY
K2) 2ND CNDSR MTR RLY
K3) EVAP MTR RLY
K5) MTR SPEED RLY
K6) ECU PWR RLY (OPT)
K7) REVERSE RLY (OPT)
K8) RETARDER RLY (OPT)
K9) 2 SPD GOV RLY (OPT)
K10) CHECK TRANS RLY (OPT)
K11) P/RACK A/C RLY (OPT)
K12) CODE RLY (OPT)

LP1) CHECK TRANS LAMP (OPT)
LP2) CHECK ENG LAMP

LC1) MTR CONTROL

SW1) CHECK TRANS SWITCH (OPT)
SW2) CHECK ENG SWITCH

7L-13-1607 REV B

PART NO.	DESCRIPTION	REV.
7L-13-1619	JACOBS ENGINE BRAKE DDEC IV	

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

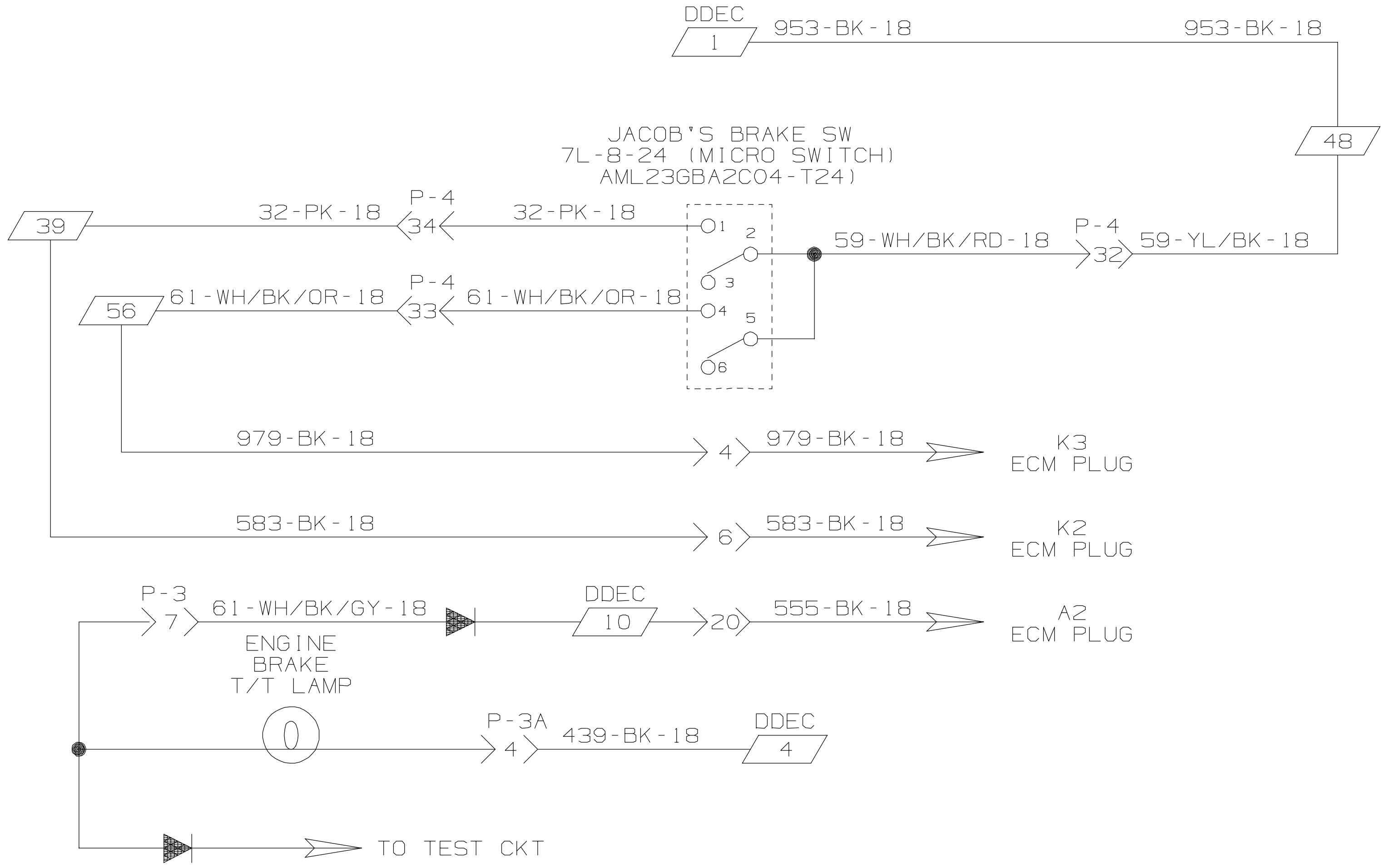
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

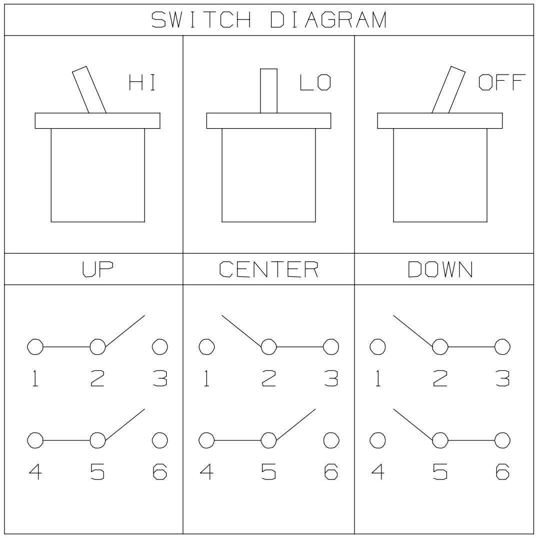
GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

JACOBS ENGINE BRAKE (DDEC IV)
102D3/102DL3
7L-13-1619 (REV B)


DDEC
1
953-BK-18
953-BK-18
48
JACOB'S BRAKE SW
7L-8-24 (MICRO SWITCH)
AML23GBA2C04-T24)
39
32-PK-18
P-4
34
32-PK-18
1
2
3
59-WH/BK/RD-18
P-4
32
59-YL/BK-18
56
61-WH/BK/OR-18
P-4
33
61-WH/BK/OR-18
4
5
6
979-BK-18
4
979-BK-18
K3
ECM PLUG
583-BK-18
6
583-BK-18
K2
ECM PLUG
P-3
7
61-WH/BK/GY-18
DDEC
10
20
555-BK-18
A2
ECM PLUG
ENGINE
BRAKE
T/T LAMP
P-3A
4
439-BK-18
DDEC
4
TO TEST CKT


SWITCH DIAGRAM
HI
LO
OFF
UP
CENTER
DOWN

PART NO.	DESCRIPTION	REV.
7L-13-1659	**ALARMS & TELL-TALE WIRING**	**A**

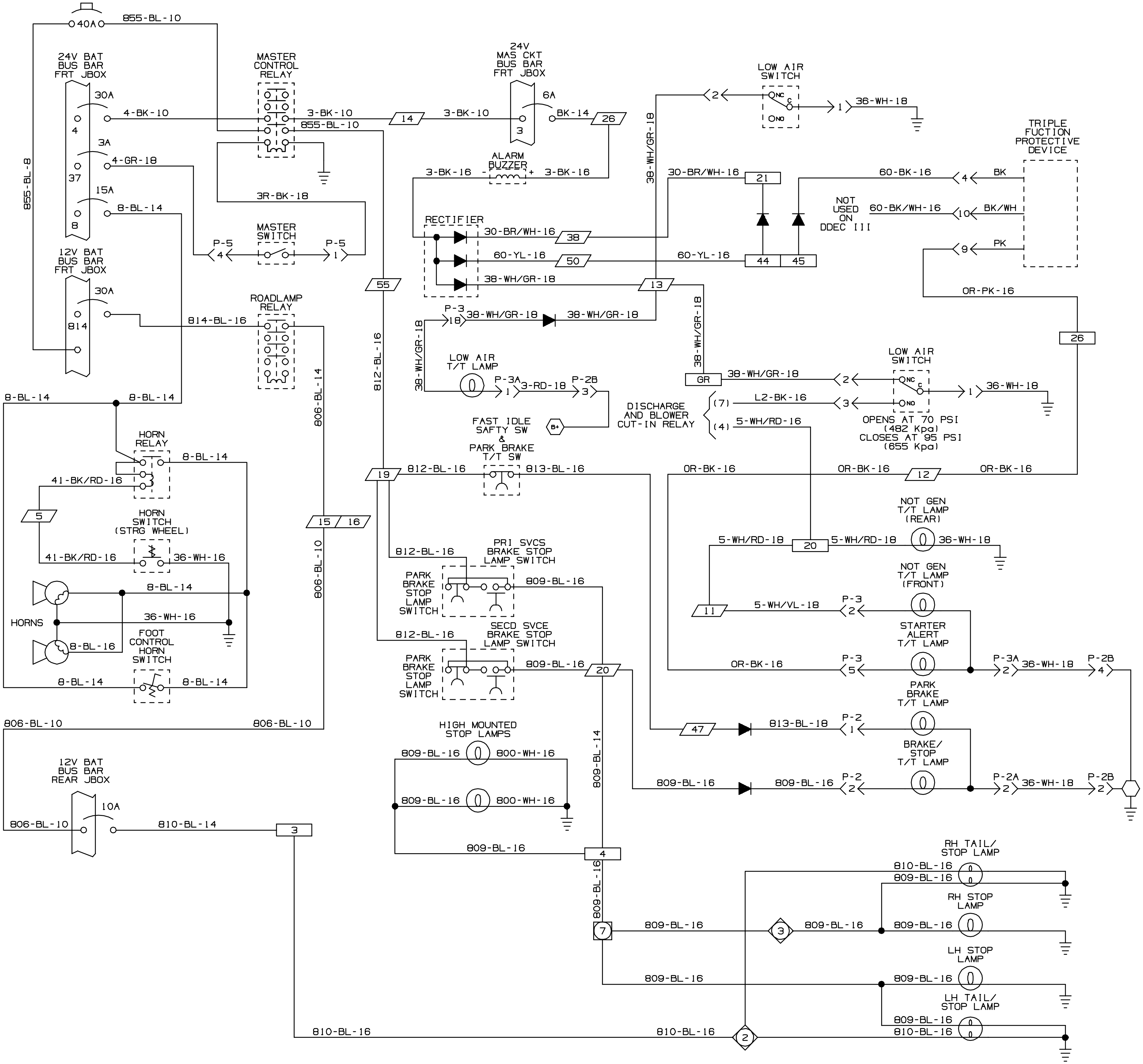
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▣	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

ALARMS & TELL–TALE WIRING
102D & 102DL3
7L–13–1659 (REV A)



40A
855-BL-10
24V BAT
BUS BAR
FRT JBOX
30A
4-BK-10
4
3A
4-GR-18
37
15A
8-BL-14
8
855-BL-8
MASTER
CONTROL
RELAY
3-BK-10
855-BL-10
14
3-BK-10
24V
MAS CKT
BUS BAR
FRT JBOX
6A
BK-14
3
26
3R-BK-18
MASTER
SWITCH
P-5
4
P-5
1
12V BAT
BUS BAR
FRT JBOX
30A
814
814-BL-16
ROADLAMP
RELAY
55
812-BL-16
806-BL-14
ALARM
BUZZER
3-BK-16
3-BK-16
RECTIFIER
30-BR/WH-16
38
60-YL-16
50
38-WH/GR-18
13
P-3
18
38-WH/GR-18
38-WH/GR-18
38-WH/GR-18
LOW AIR
T/T LAMP
P-3A
1
3-RD-18
P-2B
3
B+
FAST IDLE
SAFTY SW
&
PARK BRAKE
T/T SW
LOW AIR
SWITCH
2
NC
C
NO
1
36-WH-18
38-WH/GR-18
30-BR/WH-16
21
44
45
60-YL-16
60-BK-16
4
BK
NOT
USED
ON
DDEC III
60-BK/WH-16
10
BK/WH
9
PK
TRIPLE
FUCTION
PROTECTIVE
DEVICE
OR-PK-16
26
38-WH/GR-18
GR
38-WH/GR-18
LOW AIR
SWITCH
2
NC
C
NO
1
36-WH-18
DISCHARGE
AND BLOWER
CUT-IN RELAY
(7)
L2-BK-16
3
(4)
5-WH/RD-16
OPENS AT 70 PSI
(482 Kpa)
CLOSES AT 95 PSI
(655 Kpa)
8-BL-14
8-BL-14
HORN
RELAY
8-BL-14
41-BK/RD-16
5
HORN
SWITCH
(STRG WHEEL)
41-BK/RD-16
36-WH-16
8-BL-14
HORNS
36-WH-16
8-BL-16
FOOT
CONTROL
HORN
SWITCH
8-BL-14
8-BL-14
15
16
806-BL-10
19
812-BL-16
813-BL-16
OR-BK-16
OR-BK-16
12
OR-BK-16
NOT GEN
T/T LAMP
(REAR)
5-WH/RD-18
20
5-WH/RD-18
36-WH-18
812-BL-16
PRI SVCS
BRAKE STOP
LAMP SWITCH
PARK
BRAKE
STOP
LAMP
SWITCH
809-BL-16
NOT GEN
T/T LAMP
(FRONT)
11
5-WH/VL-18
P-3
2
812-BL-16
SECD SVCE
BRAKE STOP
LAMP SWITCH
PARK
BRAKE
STOP
LAMP
SWITCH
809-BL-16
20
STARTER
ALERT
T/T LAMP
OR-BK-16
P-3
5
P-3A
2
36-WH-18
P-2B
4
PARK
BRAKE
T/T LAMP
47
813-BL-18
P-2
1
806-BL-10
806-BL-10
HIGH MOUNTED
STOP LAMPS
809-BL-16
800-WH-16
809-BL-16
800-WH-16
809-BL-14
BRAKE/
STOP
T/T LAMP
809-BL-16
809-BL-16
P-2
2
P-2A
2
36-WH-18
P-2B
2
12V BAT
BUS BAR
REAR JBOX
10A
806-BL-10
810-BL-14
3
809-BL-16
4
809-BL-16
RH TAIL/
STOP LAMP
810-BL-16
809-BL-16
RH STOP
LAMP
7
809-BL-16
3
809-BL-16
809-BL-16
LH STOP
LAMP
809-BL-16
809-BL-16
LH TAIL/
STOP LAMP
809-BL-16
810-BL-16
810-BL-16
2
810-BL-16

PART NO.	DESCRIPTION	REV.
7L-13-1687	DECAL INSTALLATION REAR J-BOX	B

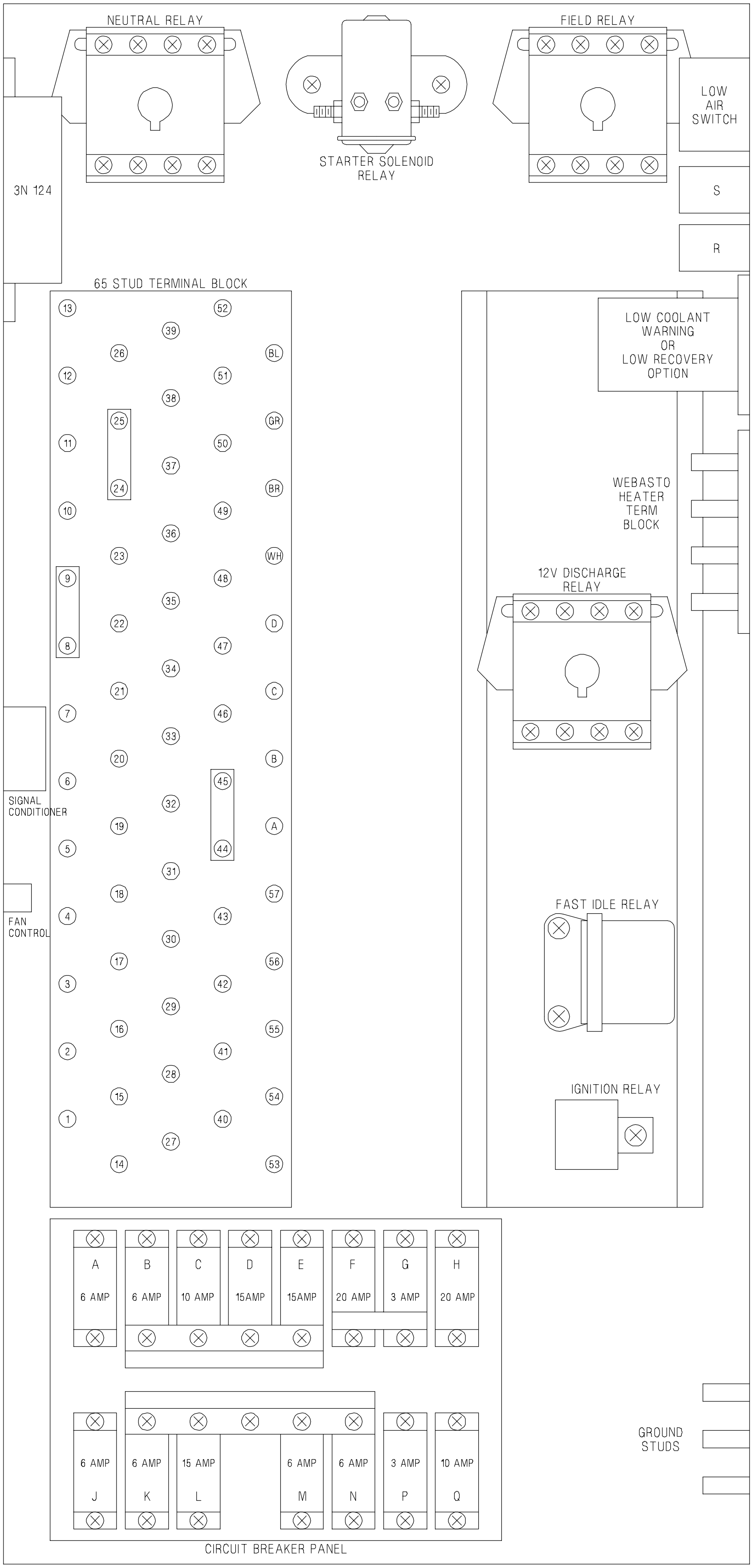
▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE
GR—GREEN

RD—RED
BR—BROWN
BK—BLACK
YL—YELLOW
OR—ORANGE

LEGEND

DECAL INSTALLATION
REAR JUNCTION BOX W/CATERPILLA
102D3 & 102DL3
7L-13-1687 (REV B)



NEUTRAL RELAY
STARTER SOLENOID RELAY
FIELD RELAY
LOW AIR SWITCH
S
R
3N 124
65 STUD TERMINAL BLOCK
LOW COOLANT WARNING OR LOW RECOVERY OPTION
WEBASTO HEATER TERM BLOCK
12V DISCHARGE RELAY
FAST IDLE RELAY
IGNITION RELAY
SIGNAL CONDITIONER
FAN CONTROL
GROUND STUDS
A 6 AMP
B 6 AMP
C 10 AMP
D 15AMP
E 15AMP
F 20 AMP
G 3 AMP
H 20 AMP
J 6 AMP
K 6 AMP
L 15 AMP
M 6 AMP
N 6 AMP
P 3 AMP
Q 10 AMP
CIRCUIT BREAKER PANEL

A) OPTION-TACH AND CLOCK
B) OPTION-LAVATORY BUZZER
C) BASIC-LAV AND ENG COMPT
D) OPTION-GALLEY POWER
E) BASIC-ALT CT

F) BASIC-TAIL LAMPS
G) BASIC-LIC PLT LPS
H) OPTION-GALLEY POWER
J) BASIC-DDEC POWER
K) BASIC-ENG STOP/FANS

L) BASIC-A/C CONTROL
M) OPTION-SPARE
N) SPARE
P) BASIC-COOLANT SENSORS
Q) OPTION-COOLANT RECOVERY

R) OPT-WATER LEVEL DETECTOR
S) OPT-TIME DELAY RELAY

7L-13-1687 REV B

PART NO.	DESCRIPTION	REV.
7L-13-1708	CHARGING & STARTING SYSTEM	C

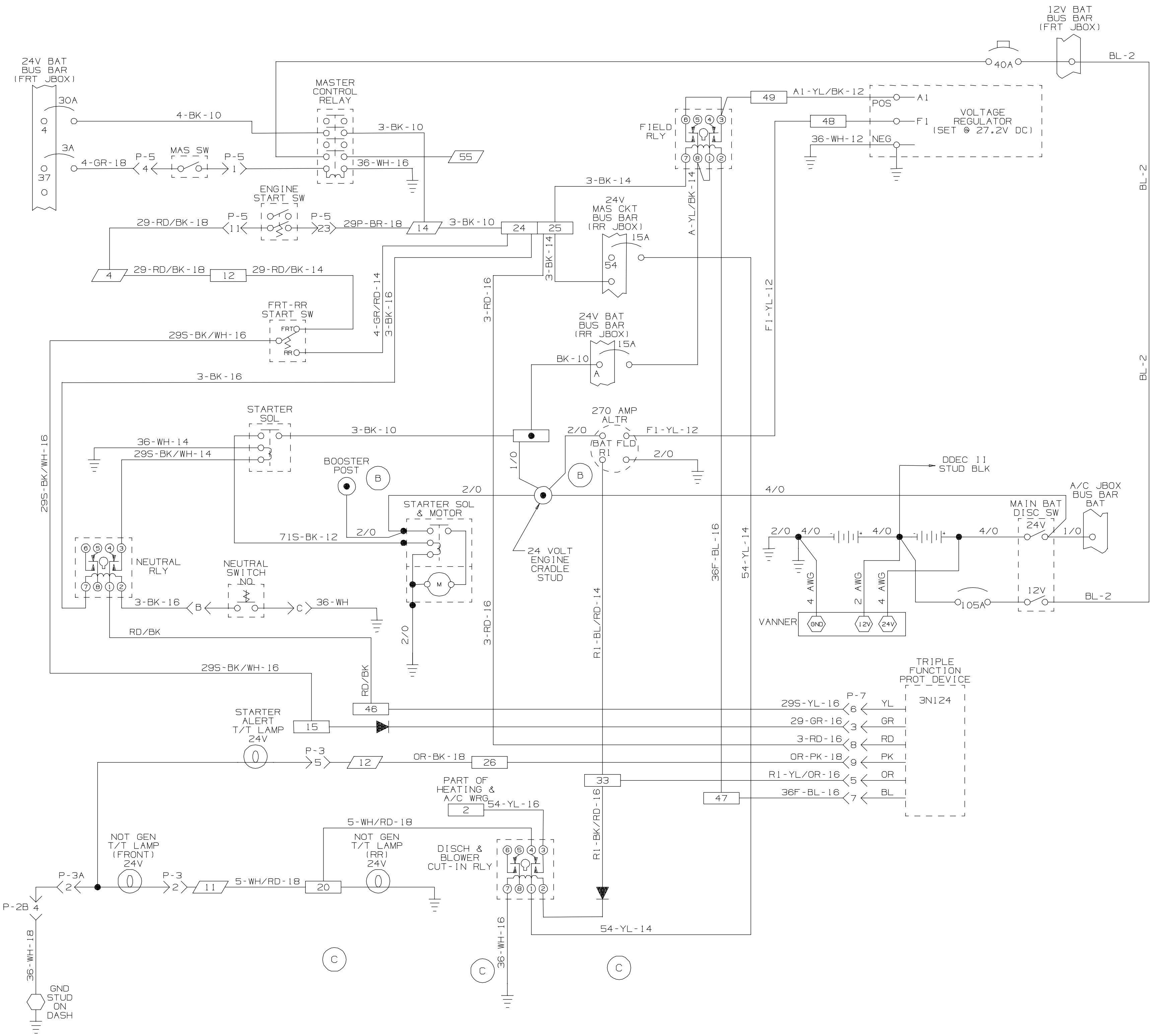
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

CHARGING & STARTING SYSTEM
102D3 & 102DL3
7L-13-1708 (REV C)


12V BAT BUS BAR (FRT JBOX)
BL-2
40A
24V BAT BUS BAR (FRT JBOX)
30A
4
3A
37
4-BK-10
4-GR-18
P-5
MAS SW
MASTER CONTROL RELAY
3-BK-10
36-WH-16
55
A1-YL/BK-12
49
48
A1
F1
POS
NEG
36-WH-12
VOLTAGE REGULATOR (SET @ 27.2V DC)
FIELD RLY
6 5 4 3
7 8 1 2
3-BK-14
A-YL/BK-14
ENGINE START SW
29-RD/BK-18
P-5
11
23
29P-BR-18
14
3-BK-10
24
25
24V MAS CKT BUS BAR (RR JBOX)
15A
54
3-BK-14
4
29-RD/BK-18
12
29-RD/BK-14
FRT-RR START SW
FRT
RR
29S-BK/WH-16
4-GR/RD-14
3-BK-16
3-RD-16
F1-YL-12
24V BAT BUS BAR (RR JBOX)
BK-10
15A
A
3-BK-16
STARTER SOL
3-BK-10
36-WH-14
29S-BK/WH-14
BOOSTER POST
B
1/0
2/0
270 AMP ALTR
BAT FLD
R1
F1-YL-12
2/0
B
DDEC II STUD BLK
2/0
4/0
STARTER SOL & MOTOR
M
71S-BK-12
2/0
24 VOLT ENGINE CRADLE STUD
A/C JBOX BUS BAR BAT
MAIN BAT DISC SW
24V
1/0
2/0
4/0
4/0
4/0
4 AWG
2 AWG
4 AWG
105A
12V
BL-2
VANNER
GND
12V
24V
29S-BK/WH-16
NEUTRAL RLY
6 5 4 3
7 8 1 2
NEUTRAL SWITCH NO
3-BK-16
B
C
36-WH
RD/BK
2/0
3-RD-16
R1-BL/RD-14
36F-BL-16
54-YL-14
29S-BK/WH-16
RD/BK
TRIPLE FUNCTION PROT DEVICE
3N124
46
P-7
29S-YL-16
6
YL
STARTER ALERT T/T LAMP 24V
15
29-GR-16
3
GR
3-RD-16
8
RD
P-3
5
12
OR-BK-18
26
OR-PK-18
9
PK
33
R1-YL/OR-16
5
OR
PART OF HEATING & A/C WRG
2
54-YL-16
47
36F-BL-16
7
BL
5-WH/RD-18
NOT GEN T/T LAMP (FRONT) 24V
NOT GEN T/T LAMP (RR) 24V
P-3A
2
P-3
2
11
5-WH/RD-18
20
DISCH & BLOWER CUT-IN RLY
6 5 4 3
7 8 1 2
R1-BK/RD-16
P-2B
4
36-WH-18
54-YL-14
C
36-WH-16
C
C
GND STUD ON DASH

PART NO.	DESCRIPTION	REV.
7L-13-1807	COOLANT LOW LEVEL WARNING & ENGINE SHUTDOWN	A

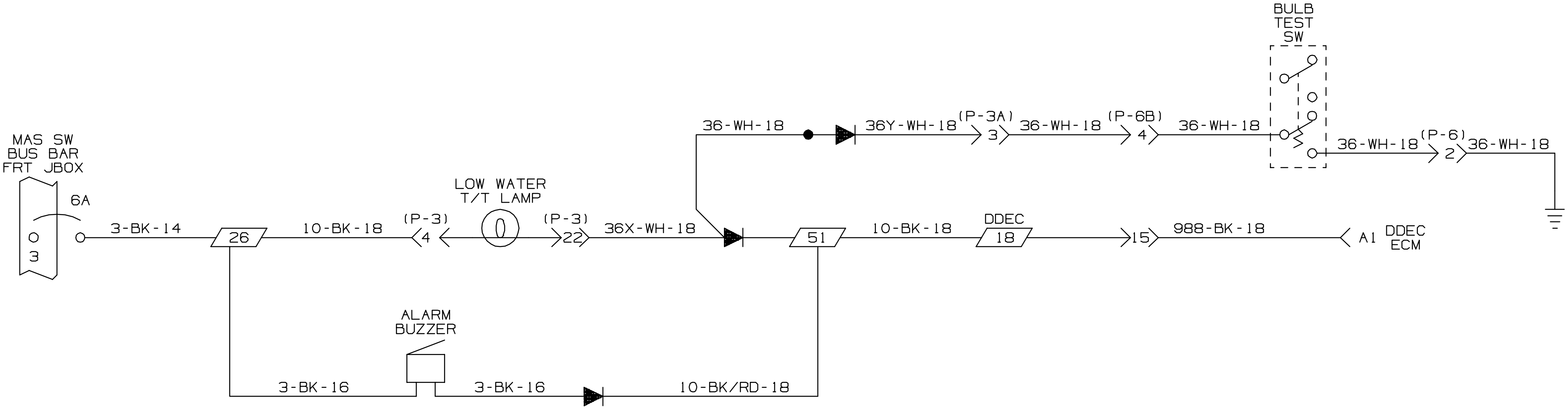
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

LOW COOLANT LEVEL WARNING
& ENGINE SHUTDOWN
102D3 & 102DL3
7L–13–1807 (REV A)


MAS SW
BUS BAR
FRT JBOX
6A
O
3
3-BK-14
26
10-BK-18
(P-3)
4
LOW WATER
T/T LAMP
(P-3)
22
36X-WH-18
36-WH-18
36Y-WH-18
(P-3A)
3
36-WH-18
(P-6B)
4
36-WH-18
BULB
TEST
SW
36-WH-18
(P-6)
2
36-WH-18
51
10-BK-18
DDEC
18
15
988-BK-18
A1
DDEC
ECM
ALARM
BUZZER
3-BK-16
3-BK-16
10-BK/RD-18

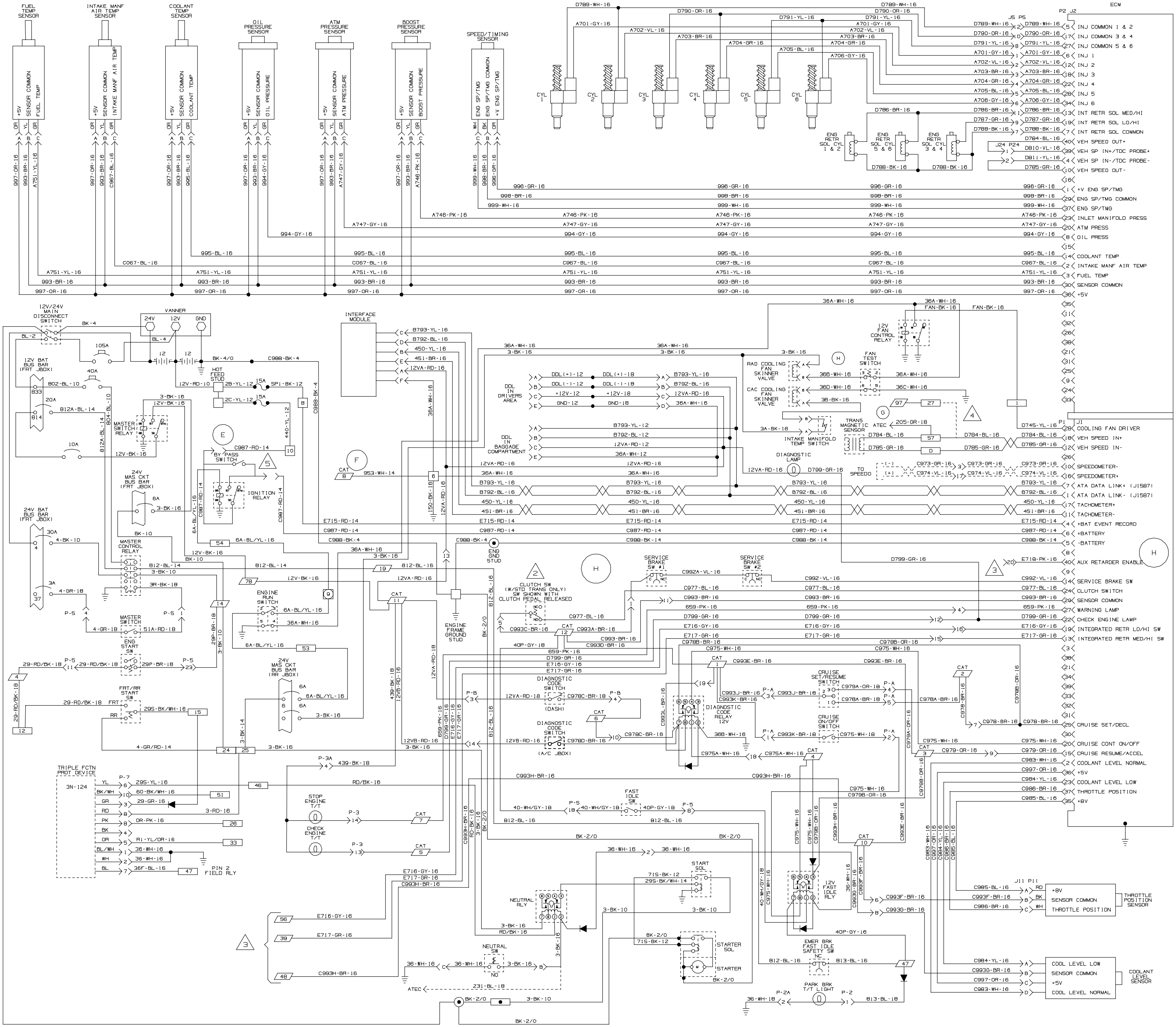
PART NO.	DESCRIPTION	REV.
7L-13-1818	ENGINE INSTALLATION CATERPILLAR	H

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

ELECTRONICALLY CONTROLLED ENGIN
102D3 & 102DL3 MODELS
CATERPILLAR INSTALLATION
7L-13-1818 (REV H)


FUEL TEMP SENSOR
+5V
SENSOR COMMON
FUEL TEMP
INTAKE MANF AIR TEMP SENSOR
INTAKE MANF AIR TEMP
COOLANT TEMP SENSOR
COOLANT TEMP
OIL PRESSURE SENSOR
OIL PRESSURE
ATM PRESSURE SENSOR
ATM PRESSURE
BOOST PRESSURE SENSOR
BOOST PRESSURE
SPEED/TIMING SENSOR
ENG SP/TMG
ENG SP/TMG COMMON
+V ENG SP/TMG
CYL 1
CYL 2
CYL 3
CYL 4
CYL 5
CYL 6
ENG RETR SOL CYL 1 & 2
ENG RETR SOL CYL 5 & 6
ENG RETR SOL CYL 3 & 4
ECM
J5 P5
P2 J2
INJ COMMON 1 & 2
INJ COMMON 3 & 4
INJ COMMON 5 & 6
INJ 1
INJ 2
INJ 3
INJ 4
INJ 5
INJ 6
INT RETR SOL MED/HI
INT RETR SOL LO/HI
INT RETR SOL COMMON
VEH SPEED OUT+
VEH SP IN+/TDC PROBE+
VEH SP IN-/TDC PROBE-
VEH SPEED OUT-
J24 P24
+V ENG SP/TMG
ENG SP/TMG COMMON
ENG SP/TMG
INLET MANIFOLD PRESS
ATM PRESS
OIL PRESS
COOLANT TEMP
INTAKE MANF AIR TEMP
FUEL TEMP
SENSOR COMMON
+5V
D789-WH-16
D790-OR-16
D791-YL-16
A701-GY-16
A702-VL-16
A703-BR-16
A704-GR-16
A705-BL-16
A706-GY-16
D786-BR-16
D787-GR-16
D788-BK-16
D784-BL-16
D810-VL-16
D811-YL-16
D785-GR-16
996-GR-16
998-BR-16
999-WH-16
A746-PK-16
A747-GY-16
994-GY-16
995-BL-16
C067-BL-16
A751-YL-16
993-BR-16
997-OR-16
12V/24V MAIN DISCONNECT SWITCH
VANNER
24V
12V
GND
BK-4
BL-2
BL-4
105A
12V BAT BUS BAR (FRT JBOX)
B02-BL-10
40A
20A
B12A-BL-14
10A
12V-BK-16
MASTER SWITCH RELAY
HOT FEED STUD
12V-RD-10
2B-YL-12
2C-YL-12
15A
5P1-BK-12
BK-4/0
C988-BK-4
440-YL-12
INTERFACE MODULE
B793-YL-16
B792-BL-16
450-YL-16
451-BR-16
12VA-RD-16
36A-WH-16
3-BK-16
DDL IN DRIVERS AREA
DDL(+)-12
DDL(+)-18
DDL(-)-12
DDL(-)-18
+12V-12
+12V-18
GND-12
GND-18
DDL IN BAGGAGE COMPARTMENT
B793-YL-12
B792-BL-12
12VA-RD-12
36A-WH-12
RAD COOLING FAN SKINNER VALVE
CAC COOLING FAN SKINNER VALVE
12V FAN CONTROL RELAY
FAN TEST SWITCH
FAN-BK-16
36B-WH-16
36D-WH-16
36C-WH-16
INTAKE MANIFOLD TEMP SWITCH
TRANS MAGNETIC SENSOR
ATEC
205-GR-18
DIAGNOSTIC LAMP
TO SPEEDO
P1 J1
COOLING FAN DRIVER
VEH SPEED IN+
VEH SPEED IN-
SPEEDOMETER-
SPEEDOMETER+
ATA DATA LINK+ (J1587)
ATA DATA LINK- (J1587)
TACHOMETER+
TACHOMETER-
+BAT EVENT RECORD
+BATTERY
-BATTERY
AUX RETARDER ENABLE
SERVICE BRAKE SW
CLUTCH SWITCH
SENSOR COMMON
WARNING LAMP
CHECK ENGINE LAMP
INTEGRATED RETR LO/HI SW
INTEGRATED RETR MED/HI SW
CRUISE SET/DECL
CRUISE CONT ON/OFF
CRUISE RESUME/ACCEL
COOLANT LEVEL NORMAL
+5V
COOLANT LEVEL LOW
THROTTLE POSITION
+8V
D745-YL-16
E715-RD-14
C987-RD-14
C988-BK-4
D799-GR-16
E718-PK-16
C992-VL-16
C977-BL-16
C993-BR-16
659-PK-16
E716-GY-16
E717-GR-16
BY PASS SWITCH
IGNITION RELAY
953-WH-14
24V MAS CKT BUS BAR (FRT JBOX)
6A
24V BAT BUS BAR (FRT JBOX)
30A
4-BK-10
3A
4-GR-18
MASTER CONTROL RELAY
B12-BL-14
3-BK-10
3R-BK-18
MASTER SWITCH
51A-RD-18
ENG START SW
29-RD/BK-18
29P-BR-18
FRT/RR START SW
29S-BK/WH-16
FRT
RR
4-GR/RD-14
ENGINE RUN SWITCH
6A-BL/YL-16
24V MAS CKT BUS BAR (RR JBOX)
ENG GND STUD
ENGINE FRAME GROUND STUD
CLUTCH SW (W/STD TRANS ONLY) SW SHOWN WITH CLUTCH PEDAL RELEASED
SERVICE BRAKE SW #1
SERVICE BRAKE SW #2
C992A-VL-16
DIAGNOSTIC CODE SWITCH (DASH)
DIAGNOSTIC CODE SWITCH (A/C JBOX)
DIAGNOSTIC CODE RELAY 12V
CRUISE SET/RESUME SWITCH
CRUISE ON/OFF SWITCH
C979A-OR-18
C978A-BR-18
C975-WH-18
C993J-BR-18
C993K-BR-18
C975A-WH-16
TRIPLE FCTN PROT DEVICE
3N-124
29S-YL-16
60-BK/WH-16
29-GR-16
3-RD-16
OR-PK-16
R1-YL/OR-16
36-WH-16
36F-BL-16
PIN 2 FIELD RLY
STOP ENGINE T/T
CHECK ENGINE T/T
FAST IDLE SW
40-WH/GY-18
40P-GY-18
START SOL
71S-BK-12
29S-BK/WH-14
NEUTRAL RLY
12V FAST IDLE RLY
STARTER SOL
STARTER
NEUTRAL SW
NO
231-BL-18
EMER BRK FAST IDLE SAFETY SW
NC
B12-BL-16
B13-BL-16
PARK BRK T/T LIGHT
36-WH-18
B13-BL-18
BK-2/0
J11 P11
THROTTLE POSITION SENSOR
+8V
SENSOR COMMON
THROTTLE POSITION
C985-BL-16
C993F-BR-16
C986-BR-16
C993G-BR-16
COOLANT LEVEL SENSOR
COOL LEVEL LOW
SENSOR COMMON
+5V
COOL LEVEL NORMAL
C984-YL-16
C997-OR-16
C983-WH-16
CAT
P-5
P-3
P-3A
P-7
P-A
P-B
P-2
P-2A
2
3
4
5
E
F
G
H

PART NO.	DESCRIPTION	REV.
7L-13-1889	MASTER ELECTRICAL WIRING DIAGRAM (CANADA)	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⧗	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

MASTER ELECTRICAL WIRING DIAGRAM
102D3 & 102DL3 (CANADA)
7L-13-1889 (REV A)
3 SHEETS

NOTES:

1) ◎ INDICATES OPTIONAL COMPONENT AS FOLLOWS:

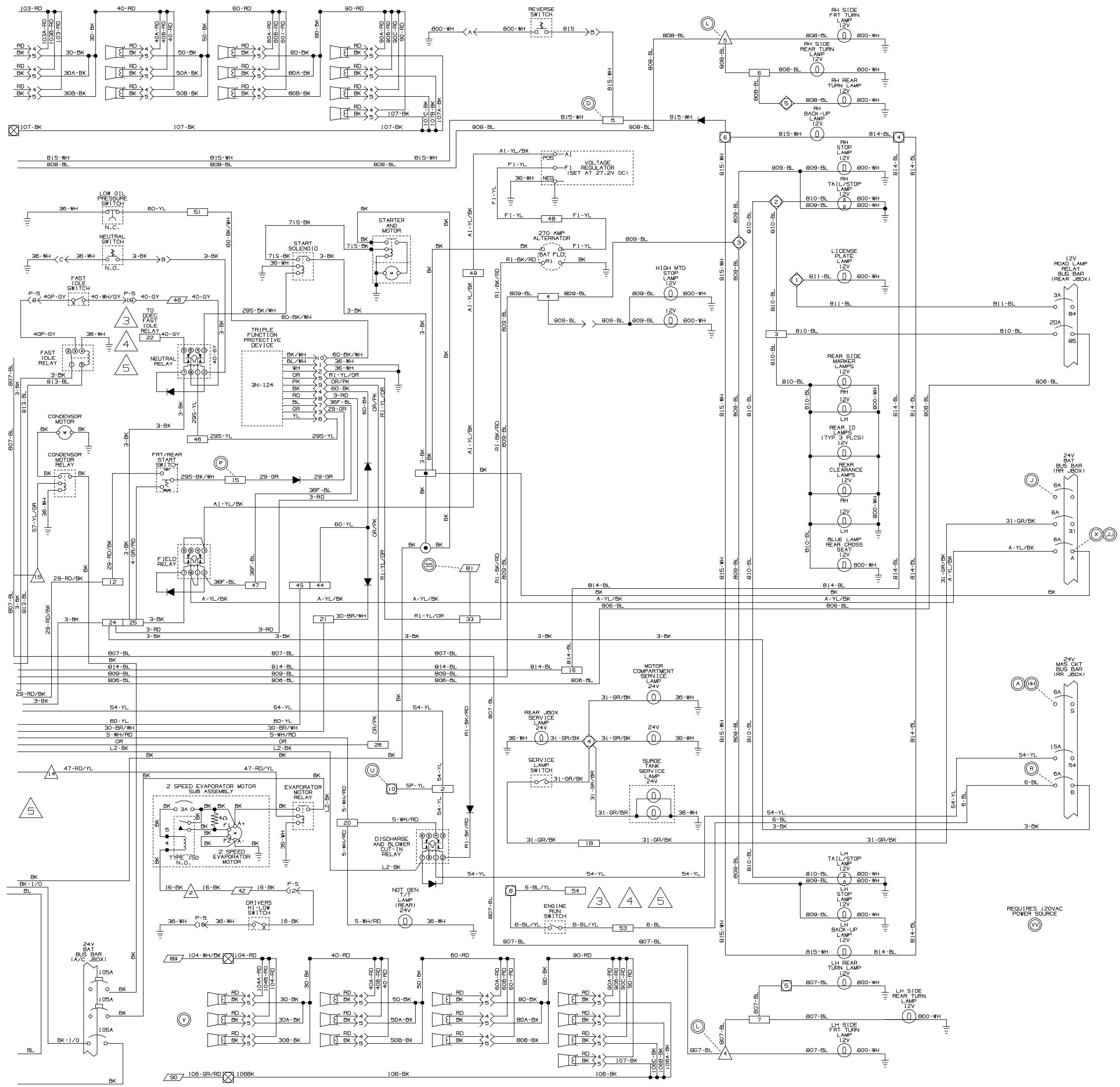
A- 2 SPEED GOVERNOR (GRID G2)
B- A/C HOURMETER (GRID D12)
C- REVERSE THROTTLE INTERLOCK (GRID C23)
D- BACK-UP ALARM (GRID B6)
E- TRAILING AXLE UNLOAD (GRID C17)
F- RETRACTABLE STEP W/BI PARTING DOORS (GRID B17)
G- HEATED MIRROR (GRID G27)
H- POWER VENTILATION (GRID I28)
J- LAVATORY (GRID E2)
K- LOW FUEL WARNING (GRID G25)
L- ADDITIONAL TURN SIGNAL (GRID A5 & J5)
M-
N-
P- THERMAL TIME DELAY (GRID E9)
R- SANGAMO MECHANICAL TACHOGRAPH (GRID H2)
S-
T- SEPARATE SWITCH FOR READING LAMPS (GRID F28)
U- ENGINE HOURMETER IN ENGINE COMPT (GRID H8)
V- ENTERTAINMENT SYSTEM 2000 (GRID B12 & J10)
W-
X- HOT BEVERAGE DISPENSER (GRID F1)
Y- LOW WATER WARNING - SHUTDOWN (GRID G26)
Z- TAG AXLE UNLOAD (GRID G26)
AA-
BB- REMOVABLE DESTINATION SIGN (GRID F28)
CC- LOW COOLANT LEVEL RECOVERY (GRID H17)
DD- RETRACTABLE STEP W/SEDAN DOOR (GRID J28)
EE- 1318-2 ARGO TACHOGRAPH (GRID J28)
FF- 1318-2/4 ARGO TACHOGRAPH (GRID J28)
GG- 1318-4 ARGO TACHOGRAPH (GRID J28)
HH- JAKE BRAKE (GRID G2)
JJ- MINI GALLEY (GRID F1)
KK- LAV OCCUPIED LAMP ABOVE FRT DSTN SIGN (GRID I28)
LL- IGN W/KEYED TYPE MASTER SW (GRID H28)
MM-
NN-
PP- CB RADIO 12V POWER SOURCE (GRID F27)
RR- ANTI THEFT (GRID G23)
SS- SIGMANETICS TACHOMETER (GRID F8)
TT- ENGINE HOURMETER IN FRT LH SERV COMPT
(GRID F14)
UU- STOP REQUEST SIGN (GRID I26)
VV- IMMERSION HEATER (GRID I2)
WW- ATEC (GRID I12)
XX- CIGARETTE LIGHTER (GRID F27)

2) EFFECTIVE 1994 MODEL

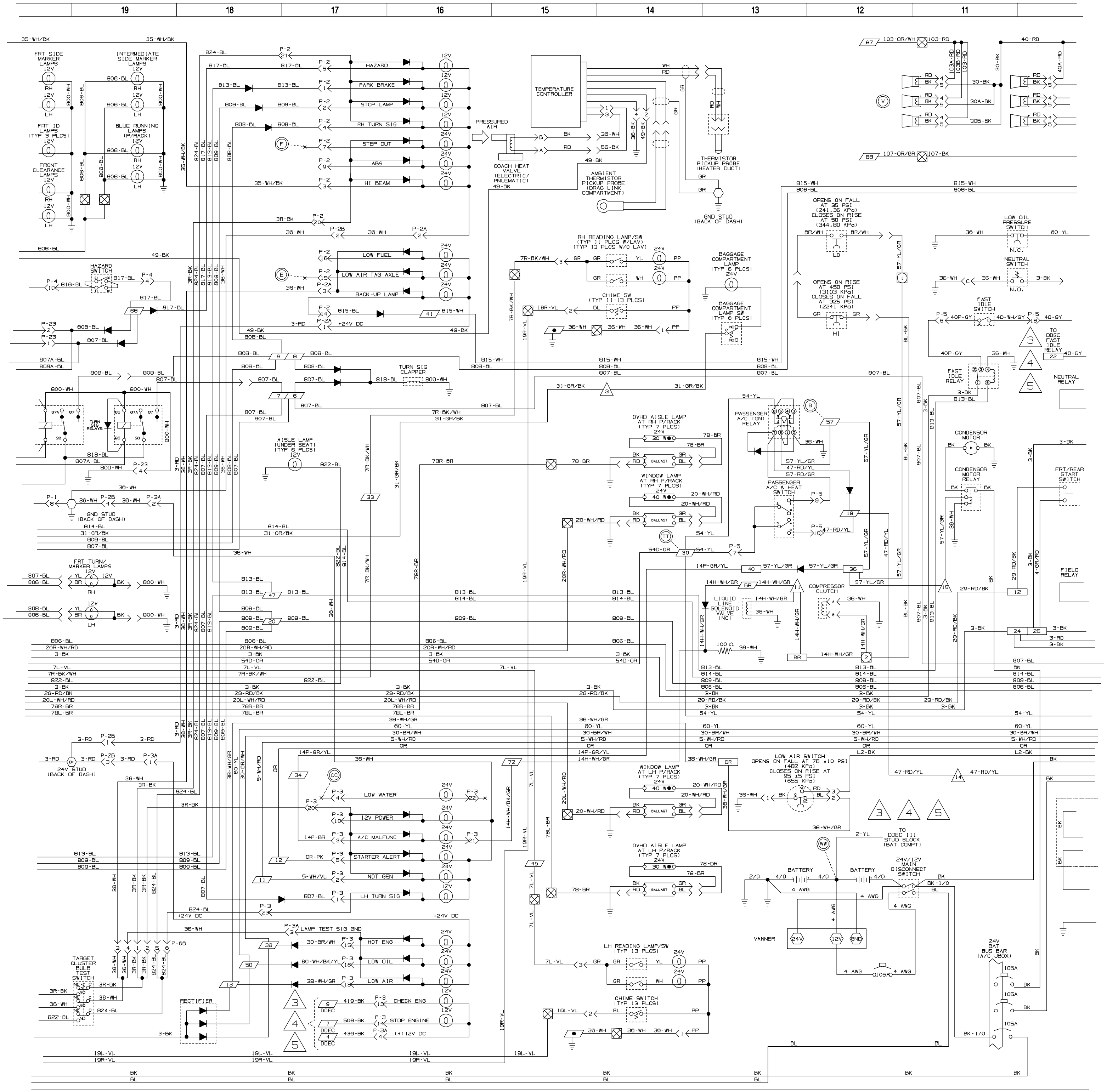
△3 SEE DDEC III SCHEMATIC FOR DDEC III WIRING FORMATION.

△4 SEE CAT SCHEMATIC FOR CAT ENGINE WIRING.

△5 SEE CUMMINS SCHEMATIC FOR CUMMINS ENGINE WIRING.

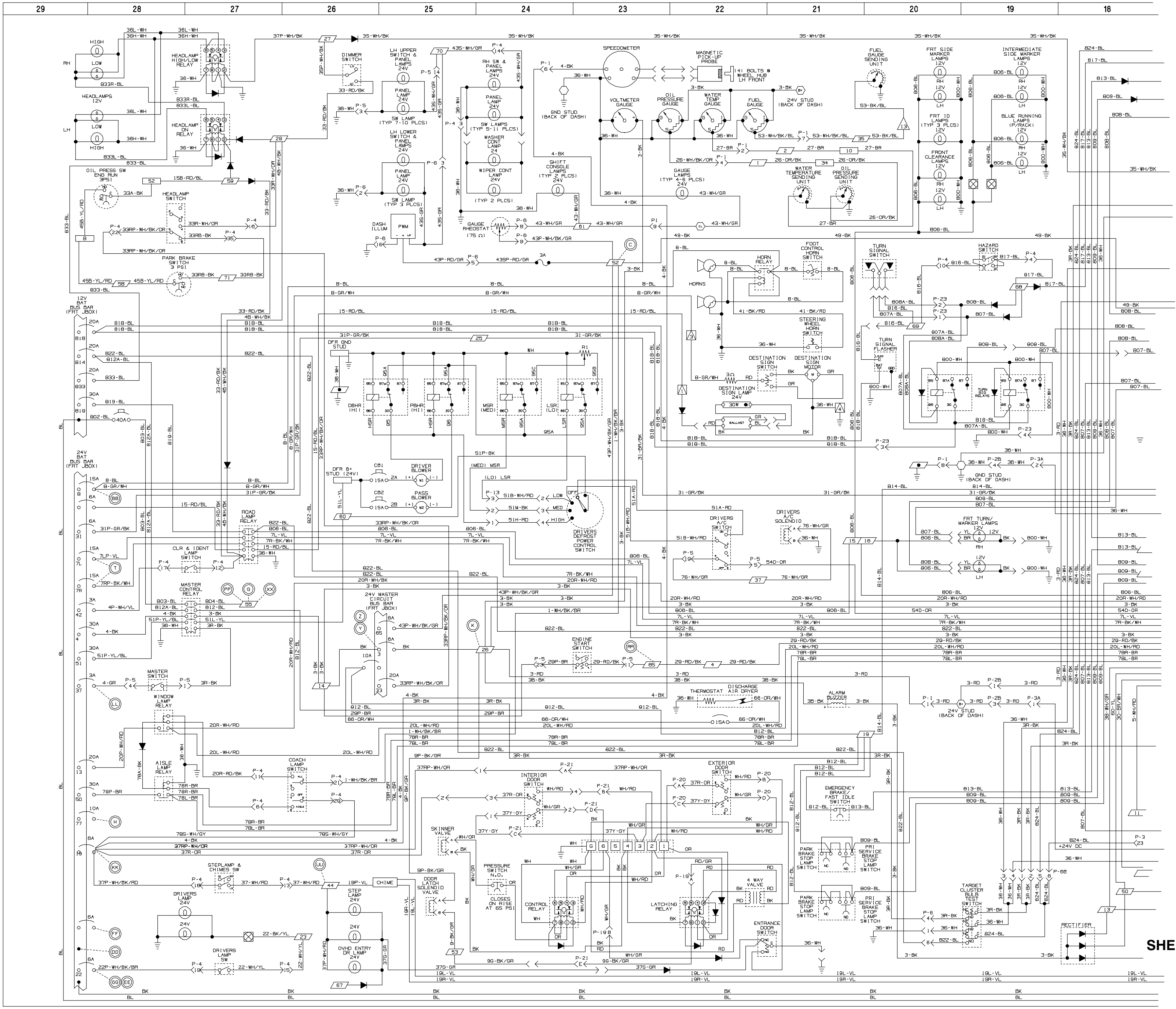

REVERSE SWITCH
RH SIDE FRT TURN LAMP 12V
RH SIDE REAR TURN LAMP 12V
RH REAR TURN LAMP 12V
RH BACK-UP LAMP 12V
VOLTAGE REGULATOR (SET AT 27.2V DC)
RH STOP LAMP 12V
RH TAIL/STOP LAMP 12V
LOW OIL PRESSURE SWITCH N.C.
NEUTRAL SWITCH N.O.
STARTER AND MOTOR
START SOLENOID
270 AMP ALTERNATOR
LICENSE PLATE LAMP 12V
HIGH MTD STOP LAMP 12V
12V ROAD LAMP RELAY BUS BAR (REAR JBOX)
FAST IDLE SWITCH
TO DDEC FAST IDLE RELAY
FAST IDLE RELAY
NEUTRAL RELAY
TRIPLE FUNCTION PROTECTIVE DEVICE
3N-124
REAR SIDE MARKER LAMPS
REAR ID LAMPS (TYP 3 PLCS) 12V
REAR CLEARANCE LAMPS
CONDENSOR MOTOR
CONDENSOR MOTOR RELAY
FRT/REAR START SWITCH
24V BAT BUS BAR (RR JBOX)
FIELD RELAY
BLUE LAMP REAR CROSS SEAT 12V
MOTOR COMPARTMENT SERVICE LAMP 24V
24V MAS CKT BUS BAR (RR JBOX)
REAR JBOX SERVICE LAMP 24V
SERVICE LAMP SWITCH
SURGE TANK SERVICE LAMP 24V
2 SPEED EVAPORATOR MOTOR SUB ASSEMBLY
TYPE 150 N.O.
2 SPEED EVAPORATOR MOTOR
EVAPORATOR MOTOR RELAY
DISCHARGE AND BLOWER CUT-IN RELAY
LH TAIL/STOP LAMP 12V
LH STOP LAMP 12V
LH BACK-UP LAMP 12V
ENGINE RUN SWITCH
NOT GEN T/T LAMP (REAR) 24V
DRIVERS HI-LOW SWITCH
REQUIRES 120VAC POWER SOURCE
24V BAT BUS BAR (A/C JBOX)
LH REAR TURN LAMP 12V
LH SIDE REAR TURN LAMP 12V
LH SIDE FRT TURN LAMP 12V

SHEET 1 OF 3



19
18
17
16
15
14
13
12
11
FRT SIDE MARKER LAMPS 12V
INTERMEDIATE SIDE MARKER LAMPS 12V
FRT ID LAMPS (TYP 3 PLCS) 12V
BLUE RUNNING LAMPS (P/RACK) 12V
FRONT CLEARANCE LAMPS 12V
HAZARD
PARK BRAKE
STOP LAMP
RH TURN SIG
STEP OUT
ABS
HI BEAM
TEMPERATURE CONTROLLER
PRESSURED AIR
COACH HEAT VALVE (ELECTRIC/ PNUEMATIC)
AMBIENT THERMISTOR PICKUP PROBE (DRAG LINK COMPARTMENT)
THERMISTOR PICKUP PROBE (HEATER DUCT)
GND STUD (BACK OF DASH)
HAZARD SWITCH
LOW FUEL
LOW AIR TAG AXLE
BACK-UP LAMP
RH READING LAMP/SW (TYP 11 PLCS W/LAV) (TYP 13 PLCS W/O LAV)
CHIME SW (TYP 11-13 PLCS)
BAGGAGE COMPARTMENT LAMP (TYP 6 PLCS) 24V
BAGGAGE COMPARTMENT LAMP SW (TYP 6 PLCS)
OPENS ON FALL AT 35 PSI (241.36 KPa) CLOSES ON RISE AT 50 PSI (344.80 KPa)
OPENS ON RISE AT 450 PSI (3103 KPa) CLOSES ON FALL AT 325 PSI (2241 KPa)
LOW OIL PRESSURE SWITCH
NEUTRAL SWITCH
FAST IDLE SWITCH
TO DDEC FAST IDLE RELAY
FAST IDLE RELAY
NEUTRAL RELAY
TURN SIG CLAPPER
TURN SIG RELAYS
AISLE LAMP (UNDER SEAT) (TYP 6 PLCS) 12V
OVHD AISLE LAMP AT RH P/RACK (TYP 7 PLCS) 24V
WINDOW LAMP AT RH P/RACK (TYP 7 PLCS) 24V
PASSENGER A/C (ON) RELAY
PASSENGER A/C & HEAT SWITCH
CONDENSOR MOTOR
CONDENSOR MOTOR RELAY
FRT/REAR START SWITCH
FIELD RELAY
LIQUID LINE SOLENOID VALVE (NC)
COMPRESSOR CLUTCH
FRT TURN/ MARKER LAMPS 12V
RH
LH
GND STUD (BACK OF DASH)
24V STUD (BACK OF DASH)
LOW WATER
12V POWER
A/C MALFUNC
STARTER ALERT
NOT GEN
LH TURN SIG
LAMP TEST SIG GND
HOT ENG
LOW OIL
LOW AIR
CHECK ENG
STOP ENGINE
(+)12V DC
DDEC
TARGET CLUSTER BULB TEST SWITCH
RECTIFIER
WINDOW LAMP AT LH P/RACK (TYP 7 PLCS) 24V
OVHD AISLE LAMP AT LH P/RACK (TYP 7 PLCS) 24V
LOW AIR SWITCH OPENS ON FALL AT 75 ±10 PSI (482 KPa) CLOSES ON RISE AT 95 ±5 PSI (655 KPa)
TO DDEC III STUD BLOCK (BAT COMPT)
BATTERY
24V/12V MAIN DISCONNECT SWITCH
VANNER
24V
12V
GND
4 AWG
LH READING LAMP/SW (TYP 13 PLCS)
CHIME SWITCH (TYP 13 PLCS)
24V BAT BUS BAR (A/C JBOX)
105A
BALLAST

SHEET 2 OF 3


29
28
27
26
25
24
23
22
21
20
19
18
RH
HIGH
LOW
HEADLAMPS 12V
LH
HEADLAMP HIGH/LOW RELAY
HEADLAMP ON RELAY
DIMMER SWITCH
LH UPPER SWITCH & PANEL LAMPS 24V
PANEL LAMP 24V
SW LAMP (TYP 7-10 PLCS)
LH LOWER SWITCH & PANEL LAMPS 24V
SW LAMP (TYP 3 PLCS)
RH SW & PANEL LAMPS 24V
SW LAMPS (TYP 5-11 PLCS)
WASHER CONT LAMP 24
WIPER CONT LAMP 24V
(TYP 2 PLCS)
SPEEDOMETER
MAGNETIC PICK-UP PROBE
(4) BOLTS @ WHEEL HUB LH FRONT
GND STUD (BACK OF DASH)
VOLTMETER GAUGE
OIL PRESSURE GAUGE
WATER TEMP GAUGE
FUEL GAUGE
24V STUD (BACK OF DASH)
FUEL GAUGE SENDING UNIT
FRT SIDE MARKER LAMPS 12V
FRT ID LAMPS (TYP 3 PLCS) 12V
FRONT CLEARANCE LAMPS 12V
INTERMEDIATE SIDE MARKER LAMPS 12V
BLUE RUNNING LAMPS (P/RACK) 12V
SHIFT CONSOLE LAMPS (TYP 2 PLCS) 24V
GAUGE LAMPS (TYP 4-6 PLCS) 24V
WATER TEMPERATURE SENDING UNIT
OIL PRESSURE SENDING UNIT
OIL PRESS SW ENG RUN (3PSI)
HEADLAMP SWITCH
PARK BRAKE SWITCH 3 PSI
DASH ILLUM
PWM
GAUGE RHEOSTAT (75 Ω)
HORN RELAY
FOOT CONTROL HORN SWITCH
HORNS
STEERING WHEEL HORN SWITCH
TURN SIGNAL SWITCH
HAZARD SWITCH
TURN SIGNAL FLASHER
TURN SIG RELAYS
DESTINATION SIGN SWITCH
DESTINATION SIGN MOTOR
DESTINATION SIGN LAMP 24V
BALLAST
12V BAT BUS BAR (FRT JBOX)
24V BAT BUS BAR (FRT JBOX)
DFR GND STUD
DBHR (HI)
PBHR (HI)
MSR (MED)
LSR (LO)
R1
DFR B+ STUD (24V)
CB1
CB2
DRIVER BLOWER
PASS BLOWER
DRIVERS DEFROST POWER CONTROL SWITCH
OFF
LOW
MED
HIGH
ROAD LAMP RELAY
CLR & IDENT LAMP SWITCH
MASTER CONTROL RELAY
24V MASTER CIRCUIT BUS BAR (FRT JBOX)
MASTER SWITCH
WINDOW LAMP RELAY
AISLE LAMP RELAY
COACH LAMP SWITCH
ENGINE START SWITCH
DRIVERS A/C SWITCH
DRIVERS A/C SOLENOID
GND STUD (BACK OF DASH)
FRT TURN/ MARKER LAMPS 12V
THERMOSTAT
DISCHARGE AIR DRYER
ALARM BUZZER
24V STUD (BACK OF DASH)
INTERIOR DOOR SWITCH
EXTERIOR DOOR SWITCH
SKINNER VALVE
PRESSURE SWITCH N.O.
CLOSES ON RISE AT 65 PSI
CONTROL RELAY
LATCHING RELAY
4 WAY VALVE
ENTRANCE DOOR SWITCH
EMERGENCY BRAKE/ FAST IDLE SWITCH
PARK BRAKE STOP LAMP SWITCH
PRI SERVICE BRAKE STOP LAMP SWITCH
TARGET CLUSTER BULB TEST SWITCH
RECTIFIER
STEPLAMP & CHIMES SW
DRIVERS LAMP 24V
CHIME
STEP LAMP 24V
OVHD ENTRY DR LAMP 24V
DOOR LATCH SOLENOID VALVE
DRIVERS LAMP SW
+24V DC
BK
BL

SHEET 3 OF 3

PART NO.	DESCRIPTION	REV.
7L-13-1890	DECAL INSTALLATION FRONT J-BOX (CATERPILLAR)	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

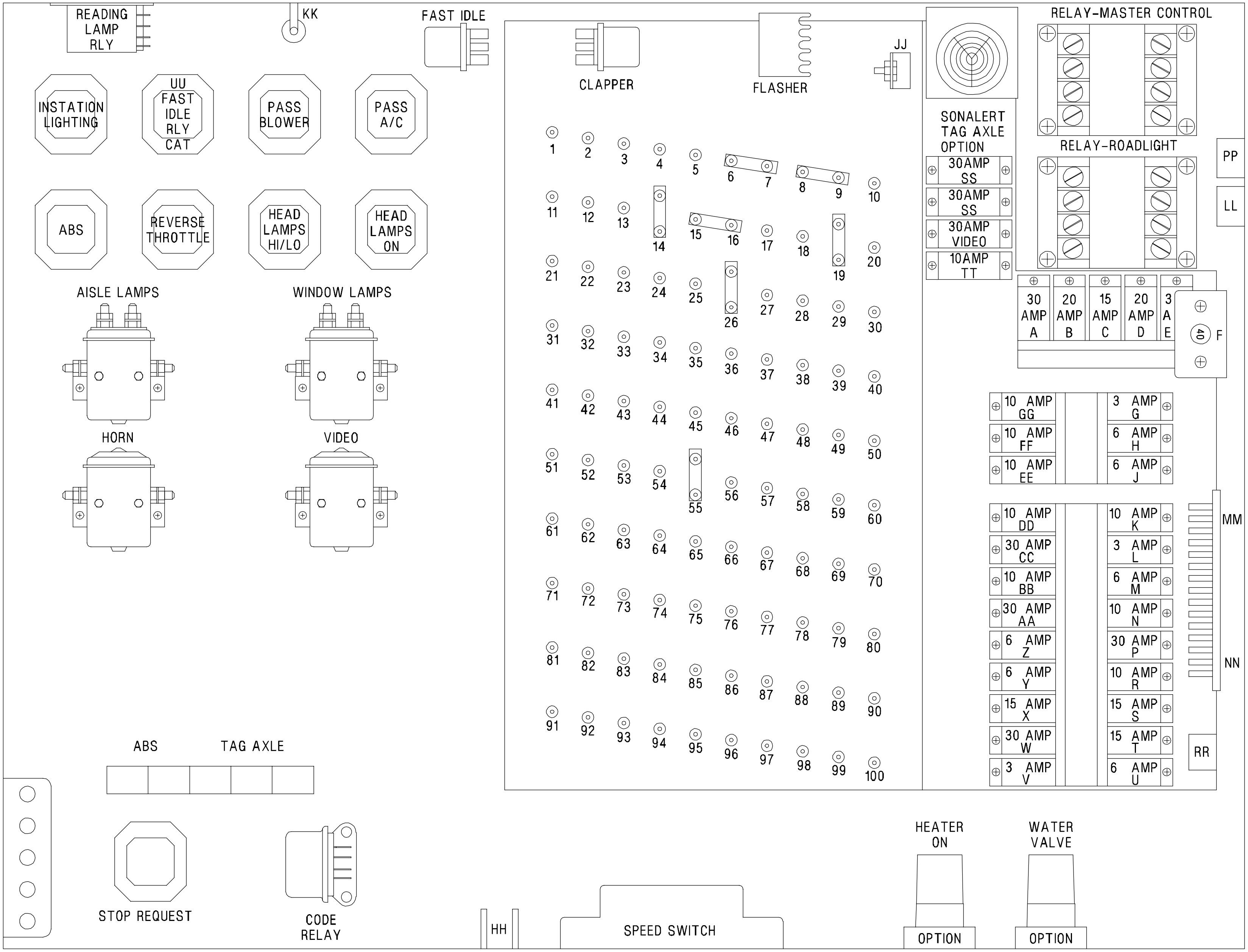
LEGEND

DECAL INSTALLATION

FRONT JUNCTION BOX W/CATERPILLAR

102D3 & 102DL3

7L-13-1890 (REV B)


READING LAMP RLY
KK
FAST IDLE
CLAPPER
FLASHER
JJ
RELAY-MASTER CONTROL
INSTATION LIGHTING
UU FAST IDLE RLY CAT
PASS BLOWER
PASS A/C
SONALERT TAG AXLE OPTION
30AMP SS
30AMP SS
30AMP VIDEO
10AMP TT
RELAY-ROADLIGHT
PP
LL
ABS
REVERSE THROTTLE
HEAD LAMPS HI/LO
HEAD LAMPS ON
30 AMP A
20 AMP B
15 AMP C
20 AMP D
3 A E
40 F
AISLE LAMPS
WINDOW LAMPS
HORN
VIDEO
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40
41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60
61 62 63 64 65 66 67 68 69 70
71 72 73 74 75 76 77 78 79 80
81 82 83 84 85 86 87 88 89 90
91 92 93 94 95 96 97 98 99 100
10 AMP GG
10 AMP FF
10 AMP EE
3 AMP G
6 AMP H
6 AMP J
10 AMP DD
30 AMP CC
10 AMP BB
30 AMP AA
6 AMP Z
6 AMP Y
15 AMP X
30 AMP W
3 AMP V
10 AMP K
3 AMP L
6 AMP M
10 AMP N
30 AMP P
10 AMP R
15 AMP S
15 AMP T
6 AMP U
MM
NN
RR
ABS
TAG AXLE
STOP REQUEST
CODE RELAY
HH
SPEED SWITCH
HEATER ON
OPTION
WATER VALVE
OPTION

A) BASIC-MARKER LAMPS
B) BASIC-HAZARD LAMPS
C) BASIC-BACKUP LAMPS
D) BASIC-HEADLAMPS
E) BASIC-BULB TEST
F) BASIC-12V MASTER
G) BASIC-HEADLIGHTS ON
H) BASIC-DASH LUMINATION
J) BASIC-DASH GAUGES
K) SPARE
L) BASIC-ROADLIGHT RELAY
M) BASIC-DRIVER'S LAMP
N) OPTION-PARCEL RACK BLOWERS
P) BASIC-WINDOW LAMPS
R) OPTION-RETRACTABLE STEP
S) BASIC-READING LAMPS-RIGHT
T) BASIC-READING LAMPS-LEFT
U) BASIC-STEP LIGHT & CHIME
V) BASIC-MASTER CONTROL RELAY
W) BASIC-AISLE LAMPS
X) BASIC-HORN
Y) BASIC-BAGGAGE LIGHTS
Z) BASIC-ENTRANCE DOOR
AA) BASIC-DRIVER'S DEFROST
BB) SPARE
CC) BASIC-MASTER SWITCH
DD) SPARE
EE) OPTION-JAKE BRAKE
FF) BASIC-BULB TEST-AIR DRYER
GG) BASIC-TAG AXLE 45 FOOT
HH) BASIC-GROUND STUDS
JJ) BASIC-RECTIFIER ASSY
KK) BASIC-RESISTOR S/A
LL) BASIC-ALARM BUZZER
MM) OPTION-ATEC STUD BLOCK
NN) BASIC-DDEC STUD BLOCK
PP) OPTION-LAV BUZZER
RR) OPTION-TAG BUZZER
SS) OPTION-INSTATION LGTS
TT) OPTION-CAT
UU) OPTION-M11 EXH/ENG BRAKE

7L-13-1890 REV B

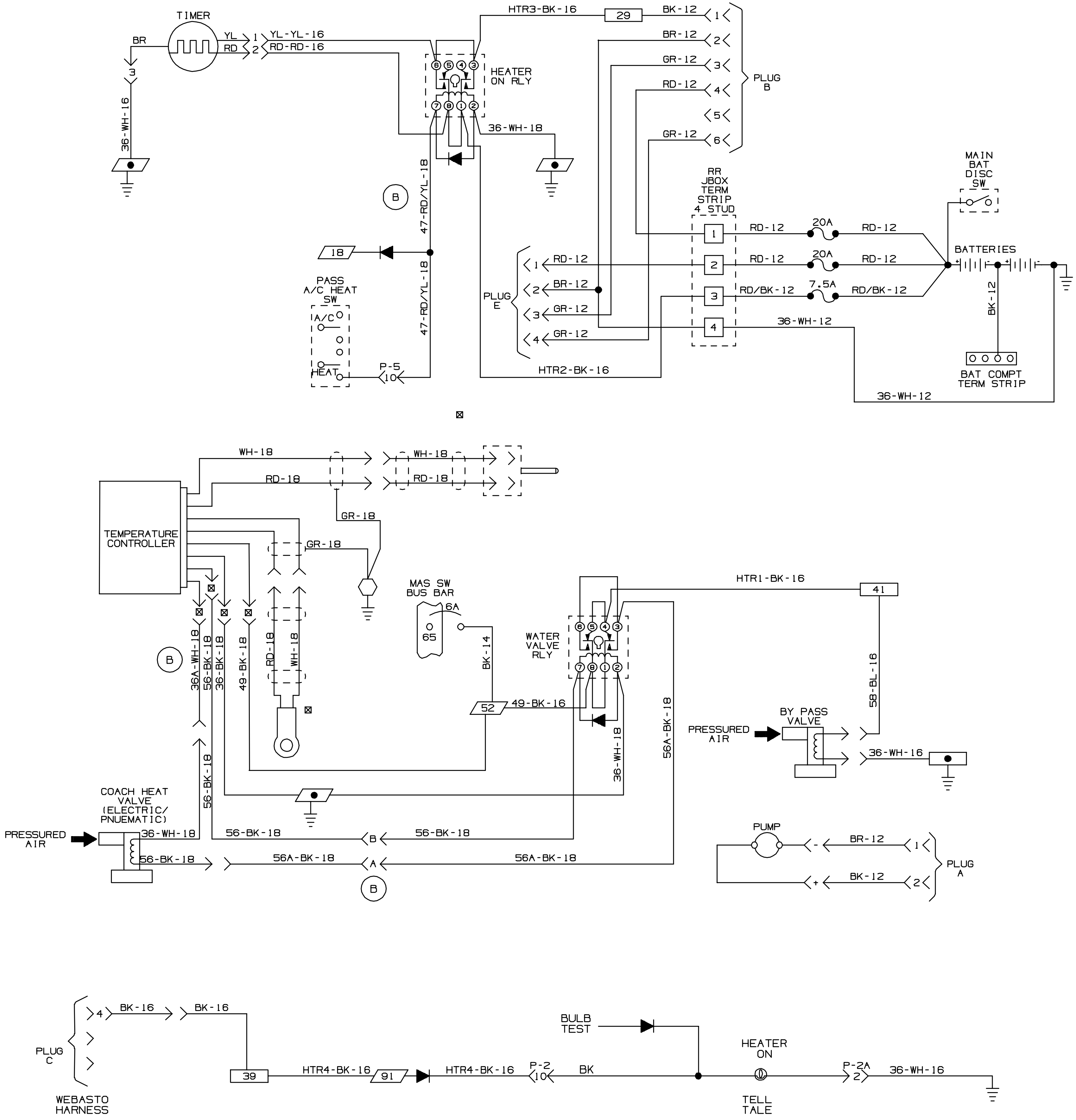
PART NO.	DESCRIPTION	REV.
7L-13-1965	AUXILIARY HEATER	

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

AUXILIARY HEATER
102D3 &102DL3
7L–13–1965 (REV C)


TIMER
BR
YL
RD
YL-YL-16
RD-RD-16
3
36-WH-16
HTR3-BK-16
29
BK-12
BR-12
GR-12
RD-12
GR-12
1
2
3
4
5
6
PLUG B
HEATER ON RLY
36-WH-18
B
47-RD/YL-18
18
47-RD/YL-18
PASS A/C HEAT SW
A/C
HEAT
P-5
10
RR JBOX TERM STRIP 4 STUD
1
2
3
4
RD-12
RD-12
RD/BK-12
36-WH-12
20A
20A
7.5A
RD-12
RD-12
RD/BK-12
MAIN BAT DISC SW
BATTERIES
BK-12
BAT COMPT TERM STRIP
36-WH-12
PLUG E
RD-12
BR-12
GR-12
GR-12
HTR2-BK-16
WH-18
RD-18
WH-18
RD-18
GR-18
GR-18
TEMPERATURE CONTROLLER
B
36A-WH-18
56-BK-18
36-BK-18
49-BK-18
RD-18
WH-18
MAS SW BUS BAR
6A
65
BK-14
52
49-BK-16
WATER VALVE RLY
36-WH-18
HTR1-BK-16
41
56A-BK-18
58-BL-16
PRESSURED AIR
BY PASS VALVE
36-WH-16
56-BK-18
COACH HEAT VALVE (ELECTRIC/ PNUEMATIC)
PRESSURED AIR
36-WH-18
56-BK-18
56-BK-18
56-BK-18
B
56A-BK-18
A
56A-BK-18
B
PUMP
BR-12
BK-12
PLUG A
PLUG C
4
BK-16
BK-16
WEBASTO HARNESS
39
HTR4-BK-16
91
HTR4-BK-16
P-2
10
BK
BULB TEST
HEATER ON
TELL TALE
P-2A
2
36-WH-16

PART NO.	DESCRIPTION	REV.
7L-13-1975	DECAL INSTALLATION FRONT J-BOX	B

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⧗	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE	GR–GREEN	RD–RED
GY–GREY	YL–YELLOW	BR–BROWN
VO–VIOLET	OR–ORANGE	BK–BLACK
BL–BLUE		

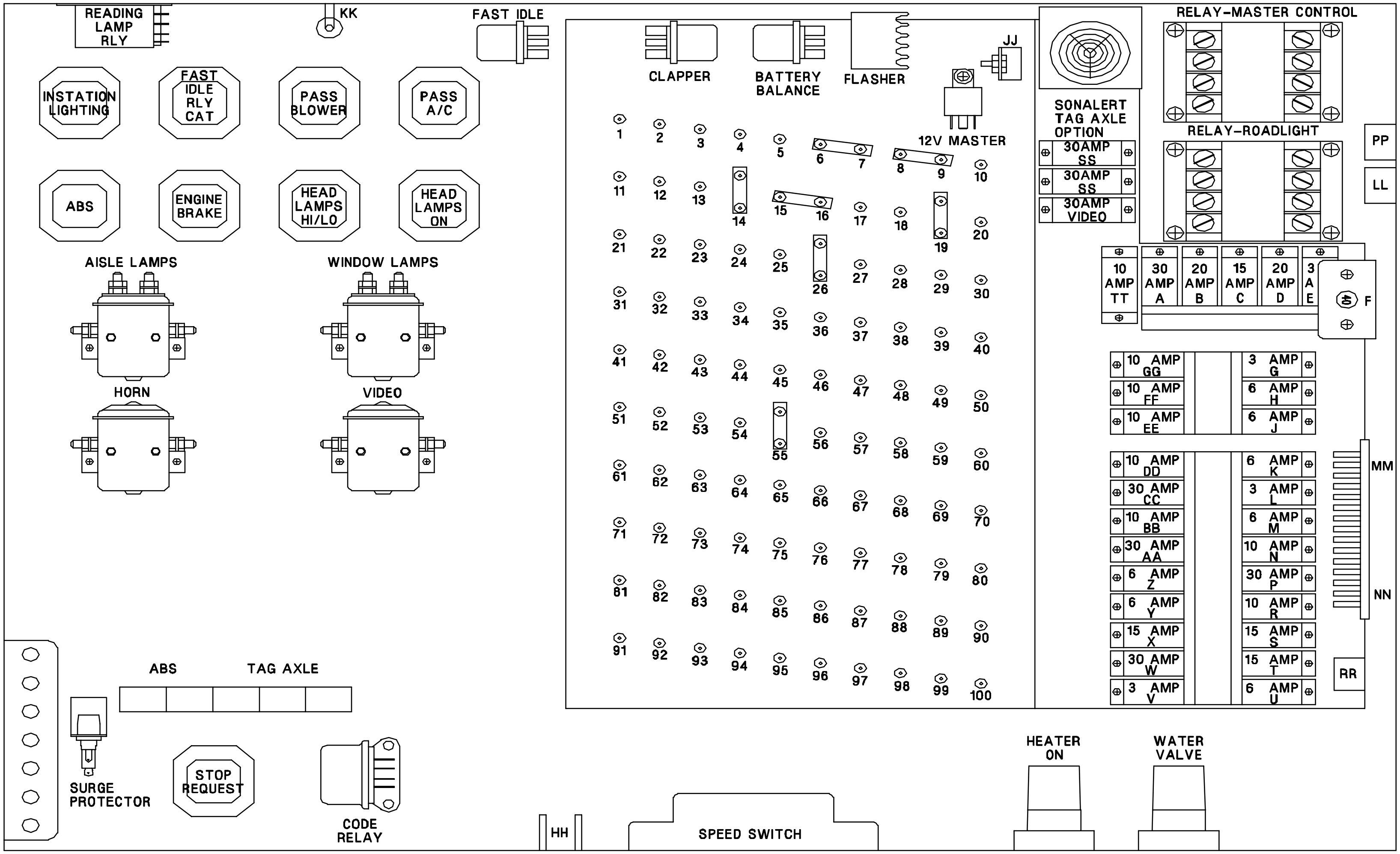
LEGEND

DECAL INSTALLATION

FRONT JUNCTION BOX W/DDEC

102D3 & 102DL3

7L-13-1975 (REV.B)


READING LAMP RLY
KK
FAST IDLE
INSTATION LIGHTING
FAST IDLE RLY CAT
PASS BLOWER
PASS A/C
ABS
ENGINE BRAKE
HEAD LAMPS HI/LO
HEAD LAMPS ON
AISLE LAMPS
WINDOW LAMPS
HORN
VIDEO
CLAPPER
BATTERY BALANCE
FLASHER
JJ
12V MASTER
1 2 3 4 5 6 7 8 9 10
11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40
41 42 43 44 45 46 47 48 49 50
51 52 53 54 55 56 57 58 59 60
61 62 63 64 65 66 67 68 69 70
71 72 73 74 75 76 77 78 79 80
81 82 83 84 85 86 87 88 89 90
91 92 93 94 95 96 97 98 99 100
SONALERT TAG AXLE OPTION
30AMP SS
30AMP SS
30AMP VIDEO
RELAY-MASTER CONTROL
RELAY-ROADLIGHT
PP
LL
10 AMP TT
30 AMP A
20 AMP B
15 AMP C
20 AMP D
3 A E
F
10 AMP GG
10 AMP FF
10 AMP EE
3 AMP G
6 AMP H
6 AMP J
10 AMP DD
30 AMP CC
10 AMP BB
30 AMP AA
6 AMP Z
6 AMP Y
15 AMP X
30 AMP W
3 AMP V
6 AMP K
3 AMP L
6 AMP M
10 AMP N
30 AMP P
10 AMP R
15 AMP S
15 AMP T
6 AMP U
MM
NN
RR
ABS
TAG AXLE
SURGE PROTECTOR
STOP REQUEST
CODE RELAY
HH
SPEED SWITCH
HEATER ON
WATER VALVE

A) BASIC-MARKER LAMPS
B) BASIC-HAZARD LAMPS
C) BASIC-BACKUP LAMPS
D) BASIC-HEADLAMPS
E) BASIC-BULB TEST
F) BASIC-12V MASTER
G) BASIC-HEADLIGHTS ON
H) BASIC-DASH LUMINATION
J) BASIC-DASH GAUGES
K) OPTION-DESTINATION SIGN

L) BASIC-ROADLIGHT RELAY
M) BASIC-DRIVER'S LAMP
N) OPTION-PARCEL RACK BLOWERS
P) BASIC-WINDOW LAMPS
R) OPTION-RETRACTABLE STEP
S) BASIC-READING LAMPS-RIGHT
T) BASIC-READING LAMPS-LEFT
U) BASIC-STEP LIGHT & CHIME
V) BASIC-MASTER CONTROL RELAY
W) BASIC-AISLE LAMPS

X) BASIC-HORN
Y) BASIC-BAGGAGE LIGHTS
Z) BASIC-ENTRANCE DOOR
AA) BASIC-DRIVER'S DEFROST
BB) SPARE
CC) BASIC-MASTER SWITCH
DD) SPARE
EE) OPTION-JAKE BRAKE
FF) BASIC-BULB TEST-AIR DRYER
GG) BASIC-TAG AXLE 45 FOOT

HH) BASIC-GROUND STUDS
JJ) BASIC-RECTIFIER ASSY
KK) BASIC-RESISTOR S/A
LL) BASIC-ALARM BUZZER
MM) OPTION-ATEC STUD BLOCK
NN) BASIC-DDEC STUD BLOCK
PP) OPTION-LAV BUZZER
RR) OPTION-TAG BUZZER
SS) OPTION-INSTATION LGTS
TT) 12V MASTER

PART NO.	DESCRIPTION	REV.
7L-13-1986	VANNER MONITOR CIRCUIT	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

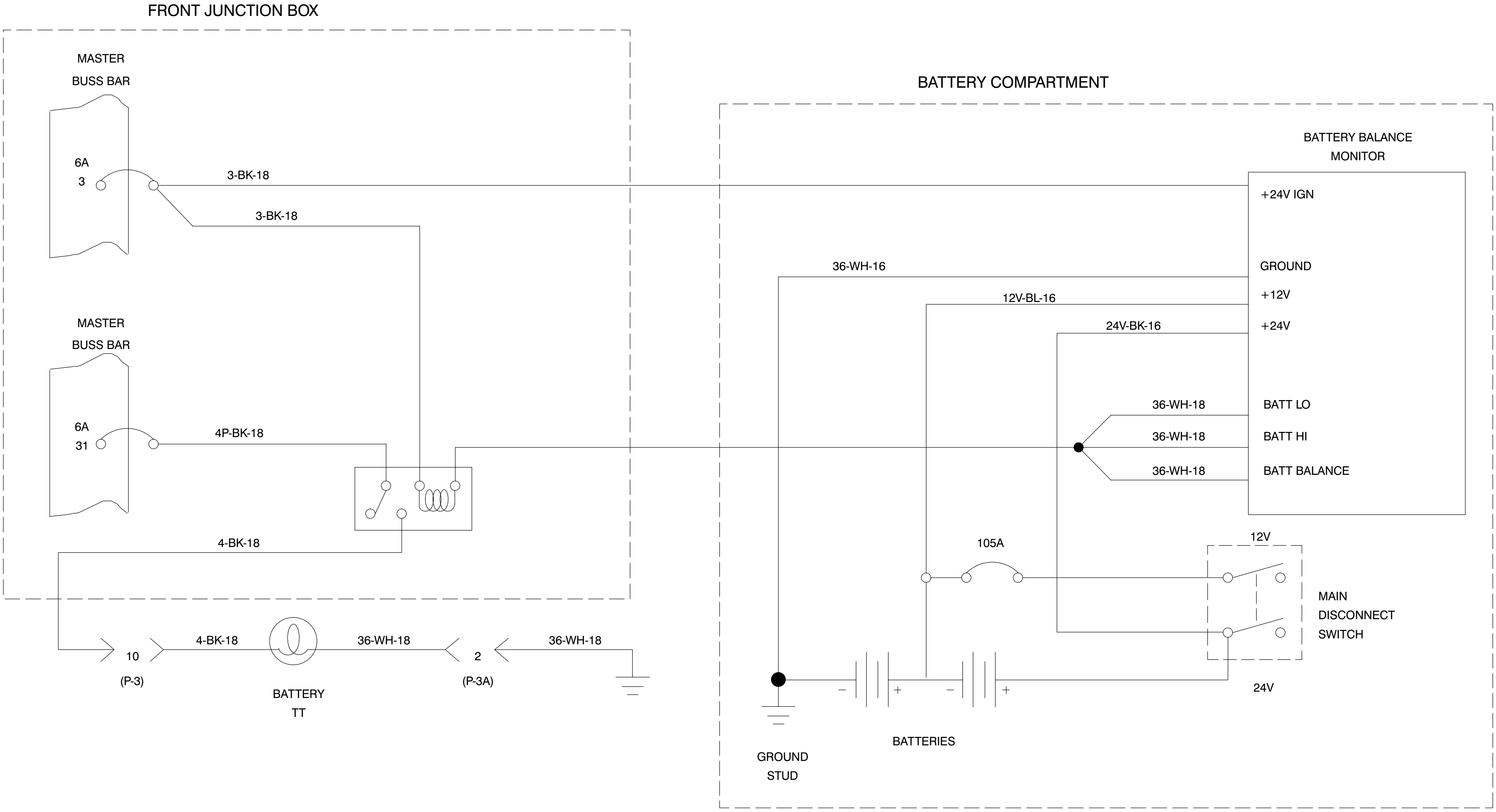
WH–WHITE GR–GREEN RD–RED
GY–GREY YL–YELLOW BR–BROWN
VO–VIOLET OR–ORANGE BK–BLACK
BL–BLUE

LEGEND

VANNER MONITOR CIRCUIT

102D3 & 102DL3 MODELS

7L-13-1986 (REV A)


FRONT JUNCTION BOX
MASTER
BUSS BAR
6A
3
3-BK-18
3-BK-18
MASTER
BUSS BAR
6A
31
4P-BK-18
4-BK-18
10
(P-3)
4-BK-18
BATTERY
TT
36-WH-18
2
(P-3A)
36-WH-18
BATTERY COMPARTMENT
BATTERY BALANCE
MONITOR
+24V IGN
36-WH-16
GROUND
12V-BL-16
+12V
24V-BK-16
+24V
36-WH-18
BATT LO
36-WH-18
BATT HI
36-WH-18
BATT BALANCE
105A
12V
MAIN
DISCONNECT
SWITCH
24V
−
+
−
+
BATTERIES
GROUND
STUD

PART NO.	DESCRIPTION	REV.
7L-13-1991	EXTERIOR COACH LIGHTING 102DS & 102DLS	C

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

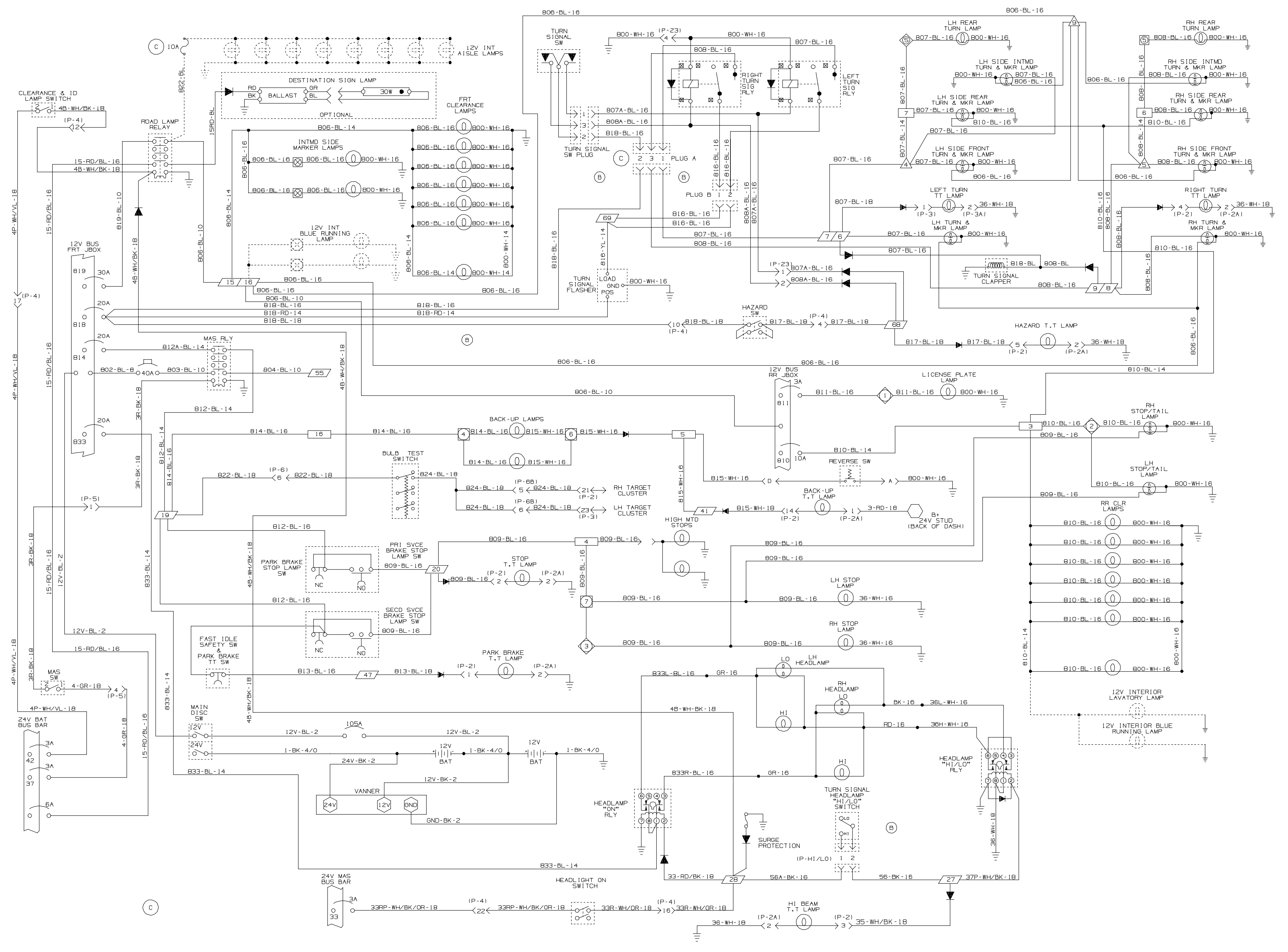
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

EXTERIOR COACH LIGHTING
HEADLAMPS, SIDE MARKER/TURN SIGNAL &
CLEARANCE/IDENTIFICATION LAMPS
102D3 & 102DL3 MODELS

7L-13-1991 (REV C)



CLEARANCE & ID LAMP SWITCH
4B-WH/BK-18
(P-4) 12
ROAD LAMP RELAY
15-RD/BL-16
4B-WH/BK-18
822-BL
10A
12V INT AISLE LAMPS
DESTINATION SIGN LAMP
BALLAST
30W
OPTIONAL
15RD-BL
FRT CLEARANCE LAMPS
806-BL-14
806-BL-16
800-WH-16
800-WH-14
INTMD SIDE MARKER LAMPS
12V INT BLUE RUNNING LAMP
TURN SIGNAL SW
TURN SIGNAL SW PLUG
807A-BL-16
808A-BL-16
818-BL-16
PLUG A
PLUG B
816-BL-16
RIGHT TURN SIG RLY
LEFT TURN SIG RLY
800-WH-16
808-BL-16
807-BL-16
(P-23)
LH REAR TURN LAMP
LH SIDE INTMD TURN & MKR LAMP
LH SIDE REAR TURN & MKR LAMP
LH SIDE FRONT TURN & MKR LAMP
RH REAR TURN LAMP
RH SIDE INTMD TURN & MKR LAMP
RH SIDE REAR TURN & MKR LAMP
RH SIDE FRONT TURN & MKR LAMP
810-BL-16
806-BL-16
LEFT TURN TT LAMP
RIGHT TURN TT LAMP
36-WH-18
(P-3) (P-3A) (P-2) (P-2A)
LH TURN & MKR LAMP
RH TURN & MKR LAMP
TURN SIGNAL CLAPPER
818-BL
808-BL
TURN SIGNAL FLASHER
LOAD GND POS
816-YL-14
800-WH-16
HAZARD SW
818-BL-18
817-BL-18
HAZARD T.T LAMP
12V BUS FRT JBOX
819 30A
818 20A
814 20A
833 20A
819-BL-10
806-BL-10
818-RD-14
818-BL-18
MAS RLY
812A-BL-14
802-BL-8
40A
803-BL-10
804-BL-10
55
812-BL-14
806-BL-10
12V BUS RR JBOX
811 3A
810 10A
811-BL-16
LICENSE PLATE LAMP
810-BL-14
BACK-UP LAMPS
814-BL-16
815-WH-16
RH STOP/TAIL LAMP
LH STOP/TAIL LAMP
809-BL-16
BULB TEST SWITCH
822-BL-18
(P-6)
824-BL-18
(P-6B)
RH TARGET CLUSTER
LH TARGET CLUSTER
REVERSE SW
BACK-UP T.T LAMP
815-WH-18
3-RD-18
B+ 24V STUD (BACK OF DASH)
RR CLR LAMPS
(P-5)
HIGH MTD STOPS
PARK BRAKE STOP LAMP SW
NC NO
PRI SVCE BRAKE STOP LAMP SW
STOP T.T LAMP
812-BL-16
LH STOP LAMP
RH STOP LAMP
SECD SVCE BRAKE STOP LAMP SW
FAST IDLE SAFETY SW & PARK BRAKE TT SW
813-BL-16
813-BL-18
PARK BRAKE T.T LAMP
12V-BL-2
15-RD/BL-16
MAS SW
4-GR-18
4P-WH/VL-18
3R-BK-18
833-BL-14
24V BAT BUS BAR
42 3A
37 3A
6A
MAIN DISC SW
12V 24V
105A
1-BK-4/0
12V BAT
24V-BK-2
12V-BK-2
VANNER
24V 12V GND
GND-BK-2
LH HEADLAMP
RH HEADLAMP
LO HI
833L-BL-16
833R-BL-16
GR-16
BK-16
36L-WH-16
RD-16
36H-WH-16
12V INTERIOR LAVATORY LAMP
12V INTERIOR BLUE RUNNING LAMP
HEADLAMP "HI/LO" RLY
HEADLAMP "ON" RLY
SURGE PROTECTION
TURN SIGNAL HEADLAMP "HI/LO" SWITCH
(P-HI/LO)
56A-BK-16
56-BK-16
37P-WH/BK-18
33-RD/BK-18
24V MAS BUS BAR
33 3A
33RP-WH/BK/OR-18
HEADLIGHT ON SWITCH
33R-WH/OR-18
HI BEAM T.T LAMP
35-WH/BK-18
36-WH-18
A B C

PART NO.	DESCRIPTION	REV.
7L-13-1992	DAYTIME RUNNING LIGHT	B

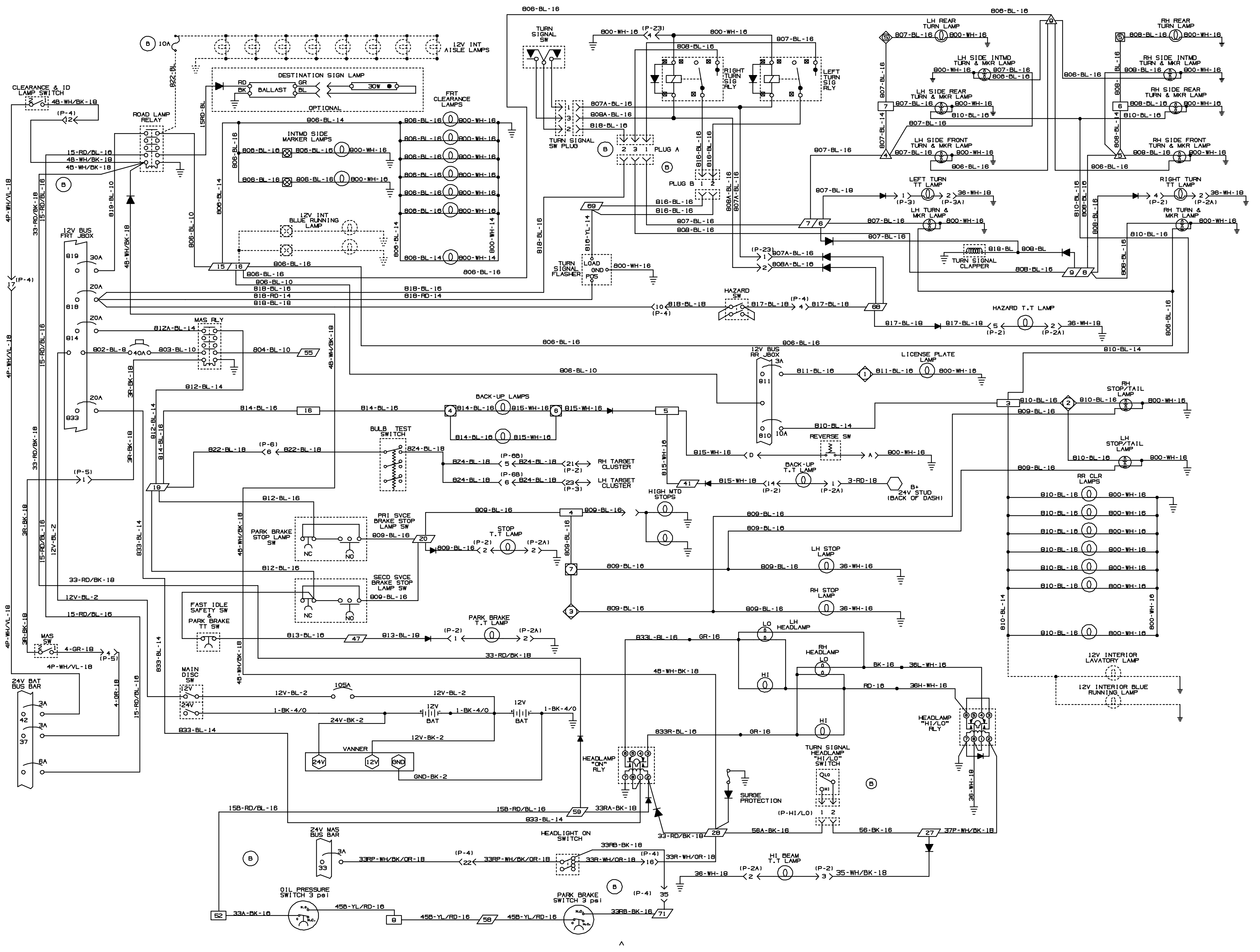
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
◘	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

DAYTIME RUNNING LIGHT CIRCUIT
102D3 & 102DL3
7L–13–1992 (REV B)


12V INT AISLE LAMPS
10A
822-BL
DESTINATION SIGN LAMP
RD
BK
BALLAST
GR
BL
30W
OPTIONAL
FRT CLEARANCE LAMPS
INTMD SIDE MARKER LAMPS
12V INT BLUE RUNNING LAMP
CLEARANCE & ID LAMP SWITCH
4B-WH/BK-18
ROAD LAMP RELAY
15-RD/BL-16
4B-WH/BK-18
15RD-BL
806-BL-14
806-BL-16
800-WH-16
800-WH-14
12V BUS FRT JBOX
819
30A
818
20A
814
20A
833
20A
MAS RLY
812A-BL-14
802-BL-8
40A
803-BL-10
804-BL-10
55
812-BL-14
806-BL-10
818-BL-16
818-RD-14
818-BL-18
15
16
TURN SIGNAL SW
TURN SIGNAL SW PLUG
807A-BL-16
808A-BL-16
818-BL-16
PLUG A
PLUG B
816-BL-16
816-YL-14
69
TURN SIGNAL FLASHER
LOAD
GND
POS
800-WH-16
(P-23)
RIGHT TURN SIG RLY
LEFT TURN SIG RLY
807-BL-16
808-BL-16
HAZARD SW
817-BL-18
(P-4)
68
HAZARD T.T LAMP
36-WH-18
LH REAR TURN LAMP
RH REAR TURN LAMP
LH SIDE INTMD TURN & MKR LAMP
RH SIDE INTMD TURN & MKR LAMP
LH SIDE REAR TURN & MKR LAMP
RH SIDE REAR TURN & MKR LAMP
LH SIDE FRONT TURN & MKR LAMP
RH SIDE FRONT TURN & MKR LAMP
810-BL-16
LEFT TURN TT LAMP
RIGHT TURN TT LAMP
LH TURN & MKR LAMP
RH TURN & MKR LAMP
TURN SIGNAL CLAPPER
818-BL
808-BL
12V BUS RR JBOX
811
3A
810
10A
811-BL-16
LICENSE PLATE LAMP
810-BL-14
RH STOP/TAIL LAMP
LH STOP/TAIL LAMP
809-BL-16
RR CLR LAMPS
BACK-UP LAMPS
814-BL-16
815-WH-16
REVERSE SW
BACK-UP T.T LAMP
3-RD-18
B+ 24V STUD (BACK OF DASH)
BULB TEST SWITCH
824-BL-18
822-BL-18
RH TARGET CLUSTER
LH TARGET CLUSTER
(P-6B)
(P-5)
19
41
HIGH MTD STOPS
PARK BRAKE STOP LAMP SW
PRI SVCE BRAKE STOP LAMP SW
SECD SVCE BRAKE STOP LAMP SW
NC
NO
20
STOP T.T LAMP
LH STOP LAMP
RH STOP LAMP
36-WH-16
FAST IDLE SAFETY SW & PARK BRAKE TT SW
813-BL-16
47
813-BL-18
PARK BRAKE T.T LAMP
33-RD/BK-18
33-RD/BK-18
4P-WH/VL-18
3R-BK-18
12V-BL-2
15-RD/BL-16
MAS SW
4-GR-18
24V BAT BUS BAR
42
37
6A
MAIN DISC SW
12V
24V
105A
1-BK-4/0
24V-BK-2
12V-BK-2
BAT
VANNER
24V
12V
GND
GND-BK-2
833-BL-14
LH HEADLAMP
RH HEADLAMP
LO
HI
833L-BL-16
GR-16
BK-16
36L-WH-16
RD-16
36H-WH-16
833R-BL-16
HEADLAMP "HI/LO" RLY
HEADLAMP "ON" RLY
SURGE PROTECTION
TURN SIGNAL HEADLAMP "HI/LO" SWITCH
(P-HI/LO)
56A-BK-16
56-BK-16
27
37P-WH/BK-18
28
59
33RA-BK-18
15B-RD/BL-16
12V INTERIOR LAVATORY LAMP
12V INTERIOR BLUE RUNNING LAMP
24V MAS BUS BAR
33
33RP-WH/BK/OR-18
HEADLIGHT ON SWITCH
33RB-BK-18
33R-WH/OR-18
HI BEAM T.T LAMP
35-WH/BK-18
OIL PRESSURE SWITCH 3 psi
PARK BRAKE SWITCH 3 psi
33A-BK-16
45B-YL/RD-16
52
8
58
71
35
B

^

PART NO.	DESCRIPTION	REV.
7L-13-2015	MASTER ELECTRICAL WIRING DIAGRAM (U.S.)	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

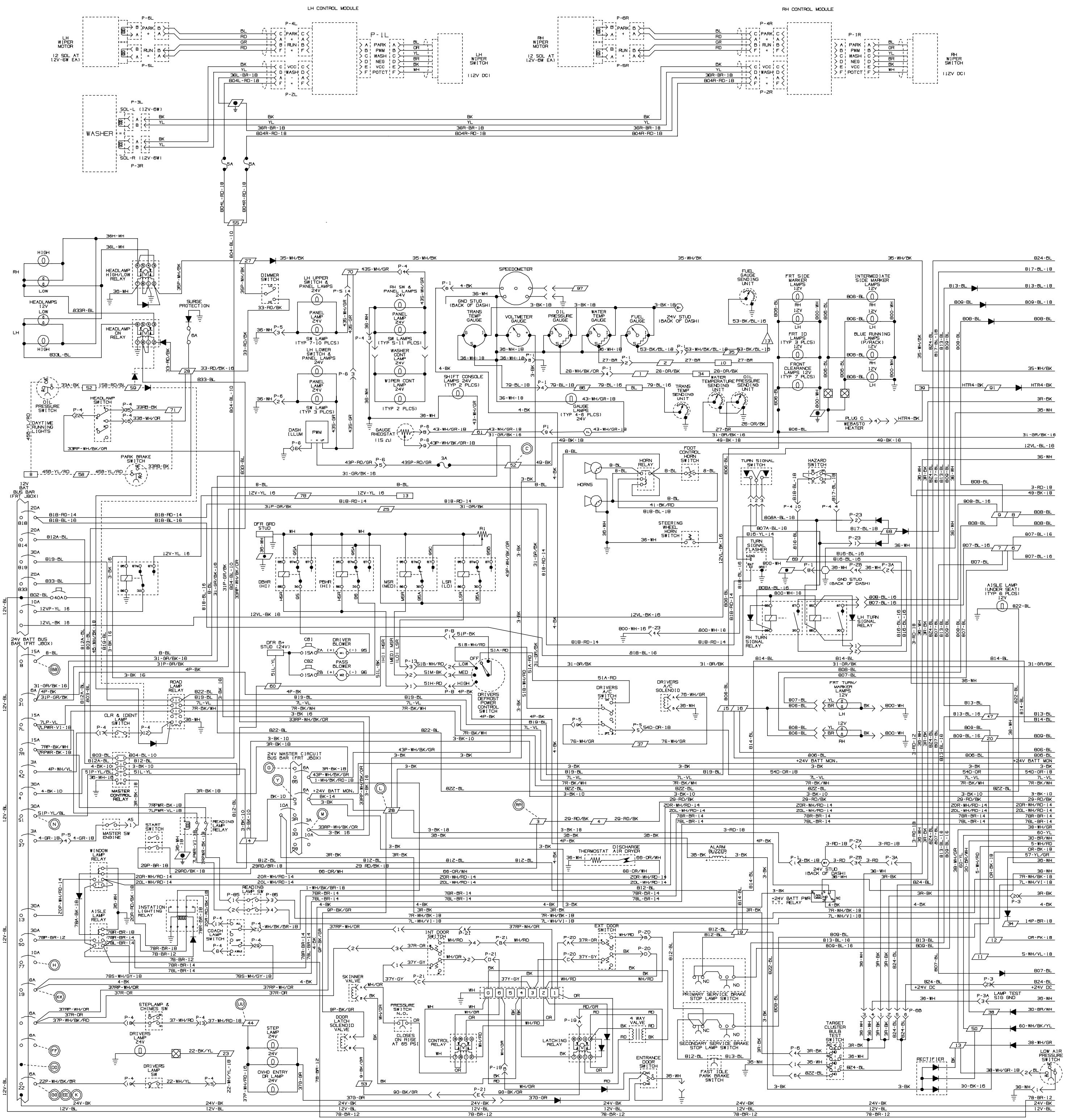
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

MASTER ELECTRICAL WIRING DIAGRAM (U. S.)
102D3 & 102DL3 MODELS
7L-13-2015 (REV A)
3 SHEETS

SHEET 1 OF 3



LH CONTROL MODULE
RH CONTROL MODULE
LH WIPER MOTOR
12 SOL AT (12V-6W EA)
RH WIPER MOTOR
LH WIPER SWITCH
RH WIPER SWITCH
(12V DC)
PARK
RUN
PWM
WASH
NEG
VCC
POTCT
WASHER
SOL-L (12V-6W)
SOL-R (12V-6W)
HEADLAMP HIGH/LOW RELAY
HEADLAMPS 12V
HIGH
LOW
RH
LH
HEADLAMP ON RELAY
SURGE PROTECTION
DIMMER SWITCH
LH UPPER SWITCH & PANEL LAMPS 24V
PANEL LAMP 24V
SW LAMP (TYP 7-10 PLCS)
LH LOWER SWITCH & PANEL LAMPS 24V
SW LAMP (TYP 3 PLCS)
RH SW & PANEL LAMPS 24V
SW LAMPS (TYP 5-11 PLCS)
WASHER CONT LAMP 24V
WIPER CONT LAMP 24V
(TYP 2 PLCS)
DASH ILLUM
PWM
GAUGE RHEOSTAT (15 Ω)
SPEEDOMETER
GND STUD (BACK OF DASH)
TRANS TEMP GAUGE
VOLTMETER GAUGE
OIL PRESSURE GAUGE
WATER TEMP GAUGE
FUEL GAUGE
24V STUD (BACK OF DASH)
SHIFT CONSOLE LAMPS 24V (TYP 2 PLCS)
GAUGE LAMPS (TYP 4-8 PLCS) 24V
TRANS TEMP SENDING UNIT
WATER TEMPERATURE SENDING UNIT
OIL PRESSURE SENDING UNIT
FUEL GAUGE SENDING UNIT
FRT SIDE MARKER LAMPS 12V
FRT ID LAMPS (TYP 3 PLCS) 12V
FRONT CLEARANCE LAMPS 12V (TYP 7 PLCS)
INTERMEDIATE SIDE MARKER LAMPS 12V
BLUE RUNNING LAMPS (P/RACK) 12V
PLUG C WEBASTO HEATER
OIL PRESSURE SWITCH
HEADLAMP SWITCH
DAYTIME RUNNING LIGHTS
PARK BRAKE SWITCH
12V BAT BUS BAR (FRT JBOX)
HORNS
HORN RELAY
FOOT CONTROL HORN SWITCH
STEERING WHEEL HORN SWITCH
TURN SIGNAL SWITCH
HAZARD SWITCH
TURN SIGNAL FLASHER
GND STUD (BACK OF DASH)
RH TURN SIGNAL RELAY
LH TURN SIGNAL RELAY
AISLE LAMP (UNDER SEAT) (TYP 6 PLCS) 12V
DFR GRD STUD
DBHR (HI)
PBHR (HI)
MSR (MED)
LSR (LO)
DFR B+ STUD (24V)
CB1
CB2
DRIVER BLOWER
PASS BLOWER
DRIVERS DEFROST POWER CONTROL SWITCH
OFF
LOW
MED
HIGH
24V BATT BUS BAR (FRT JBOX)
ROAD LAMP RELAY
CLR & IDENT LAMP SWITCH
MASTER CONTROL RELAY
24V MASTER CIRCUIT BUS BAR (FRT JBOX)
+24V BATT MON.
DRIVERS A/C SWITCH
DRIVERS A/C SOLENOID
FRT TURN/ MARKER LAMPS 12V
START SWITCH
MASTER SW ENGINE
READING LAMP RELAY
WINDOW LAMP RELAY
AISLE LAMP RELAY
INSTATION LIGHTING RELAY
READING LAMP SW
COACH LAMP SWITCH
THERMOSTAT AIR DRYER
DISCHARGE
ALARM BUZZER
24V STUD (BACK OF DASH)
+24V BATT PWR T.T. RELAY
INT DOOR SWITCH
EXT DOOR SWITCH
SKINNER VALVE
PRESSURE SWITCH N.O.
CLOSES ON RISE AT 65 PSI
DOOR LATCH SOLENOID VALVE
CONTROL RELAY
LATCHING RELAY
4 WAY VALVE
ENTRANCE DOOR SWITCH
PRIMARY SERVICE BRAKE STOP LAMP SWITCH
SECONDARY SERVICE BRAKE STOP LAMP SWITCH
FAST IDLE PARK BRAKE SWITCH
TARGET CLUSTER BULB TEST SWITCH
RECTIFIER
LAMP TEST SIG GND
LOW AIR PRESSURE SWITCH
STEPLAMP & CHIMES SW
DRIVERS LAMP 24V
DRIVERS LAMP SW
STEP LAMP 24V
OVHD ENTRY ID LAMP 24V

NOTES:

1. ◎ INDICATES OPTIONAL COMPONENT AS FOLLOWS:

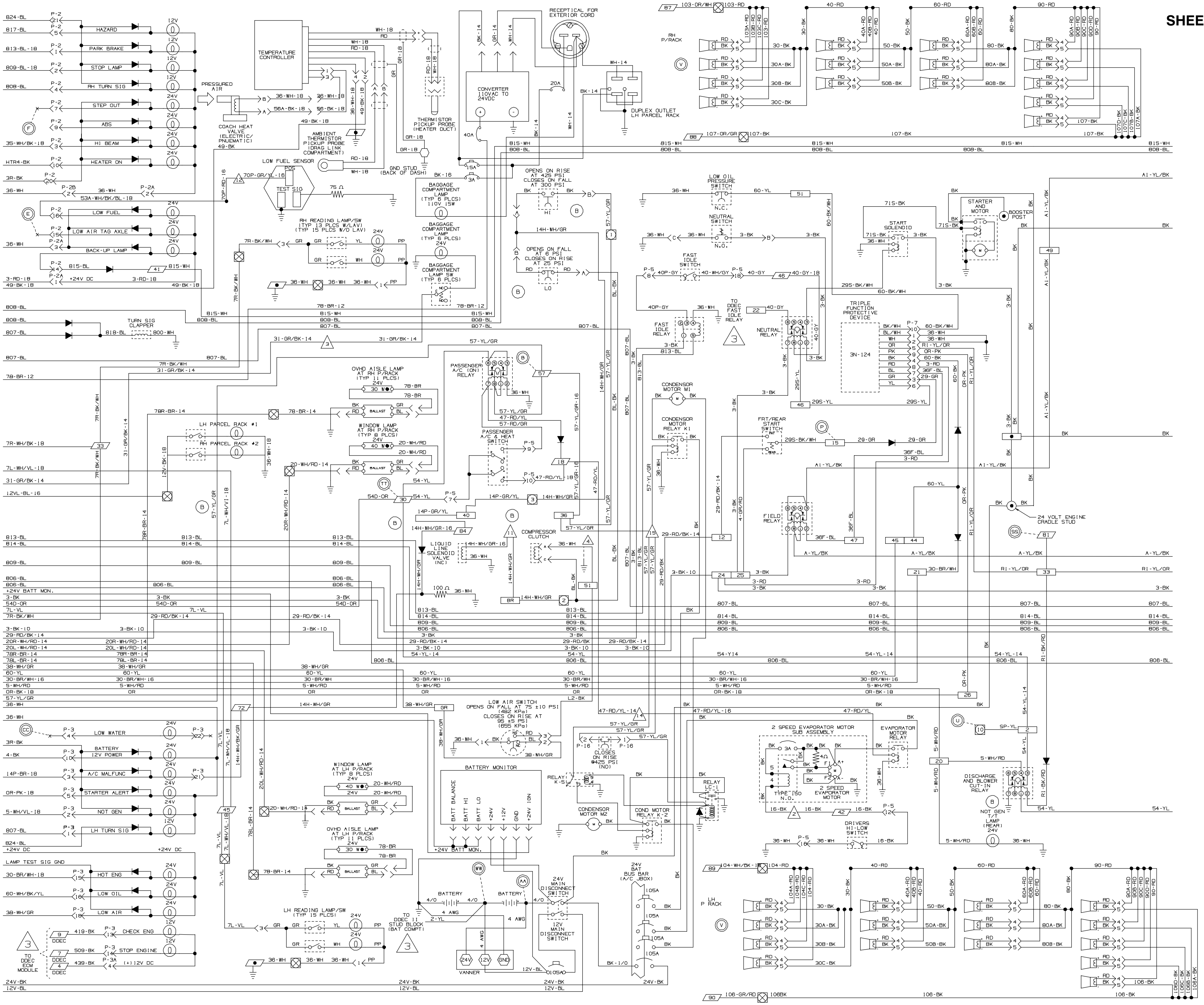
A	2 SPEED GOVERNOR (GRID B5 SHEET 3)
B	A/C HOURMETER (GRID C6 SHEET 2)
C	REVERSE THROTTLE INTERLOCK (GRID C6 SHEET 1)
D	BACK-UP ALARM (GRID D7 SHEET 3)
E	TRAILING AXLE UNLOAD (GRID D8 SHEET 2)
F	RETRACTABLE STEP (GRID D8 SHEET 2)
G	VIDEO SYSTEMS (GRID D7 SHEET 1)
H	POWER VENTILATION (GRID A8 SHEET 1)
J	LAVATORY (GRID C5 SHEET 3)
K	DRIVERS MAP LIGHT (GRID B8 SHEET 1)
L	LOW FUEL WARNING (GRID B6 SHEET 1)
M	DATA HUB & LOGGER (GRID D6 SHEET 1)
N	2-110V 3-PRONG PLUG-INS (GRID D8 SHEET 1)
P	THERMAL TIME DELAY (GRID C4 SHEET 2)
R	
S	
T	
U	ENGINE HOURMETER IN ENGINE COMPARTMENT (GRID B4 SHEET 2)
V	ENTERTAINMENT SYSTEM 2000 (GRID A5 SHEET 2 & D6 SHEET 2)
W	
X	HOT BEVERAGE DISPENSER (GRID B5 SHEET 3)
Y	LOW WATER WARNING-SHUTDOWN (GRID B7 SHEET 1)
Z	
AA	RICON WCL (GRID B6 SHEET 2)
BB	REMOVABLE DESTINATION SIGN (GRID C8 SHEET 1)
CC	LOW COOLANT LEVEL RECOVERY (GRID B8 SHEET 2)
DD	RETRACTABLE STEP WITH SEDAN DOOR (GRID A8 SHEET 1)
EE	1318-2 ARGO TACHOGRAPH (GRID A8 SHEET 1)
FF	1318-2/4 ARGO TACHOGRAPH (GRID A8 SHEET 1)
GG	1318-4 ARGO TACHOGRAPH (GRID A8 SHEET 1)
HH	JAKE BRAKE (GRID B5 SHEET 3)
JJ	MINI GALLEY (GRID B5 SHEET 3)
KK	LAVATORY OCCUPIED LAMP ABOVE FRONT DESTINATION SIGN (GRID A8 SHEET 1)
LL	
MM	
NN	
PP	
RR	ANTI THEFT (GRID B6 SHEET 1)
SS	SIGMANETICS TACHOMETER (GRID B3 SHEET 3)
TT	ENGINE HOURMETER IN FRONT LEFT HAND SERVICE COMPARTMENT (GRID C7 SHEET 2)
UU	STOP REQUEST SIGN (GRID A7 SHEET 1)
VV	
WW	ATEC (GRID A6 SHEET 2)
XX	

2. EFFECTIVE 1993 MODEL.

△3 SEE DDEC II SCHEMATIC, 7L-13-1238, FOR DDEC II WIRING INFORMATION.

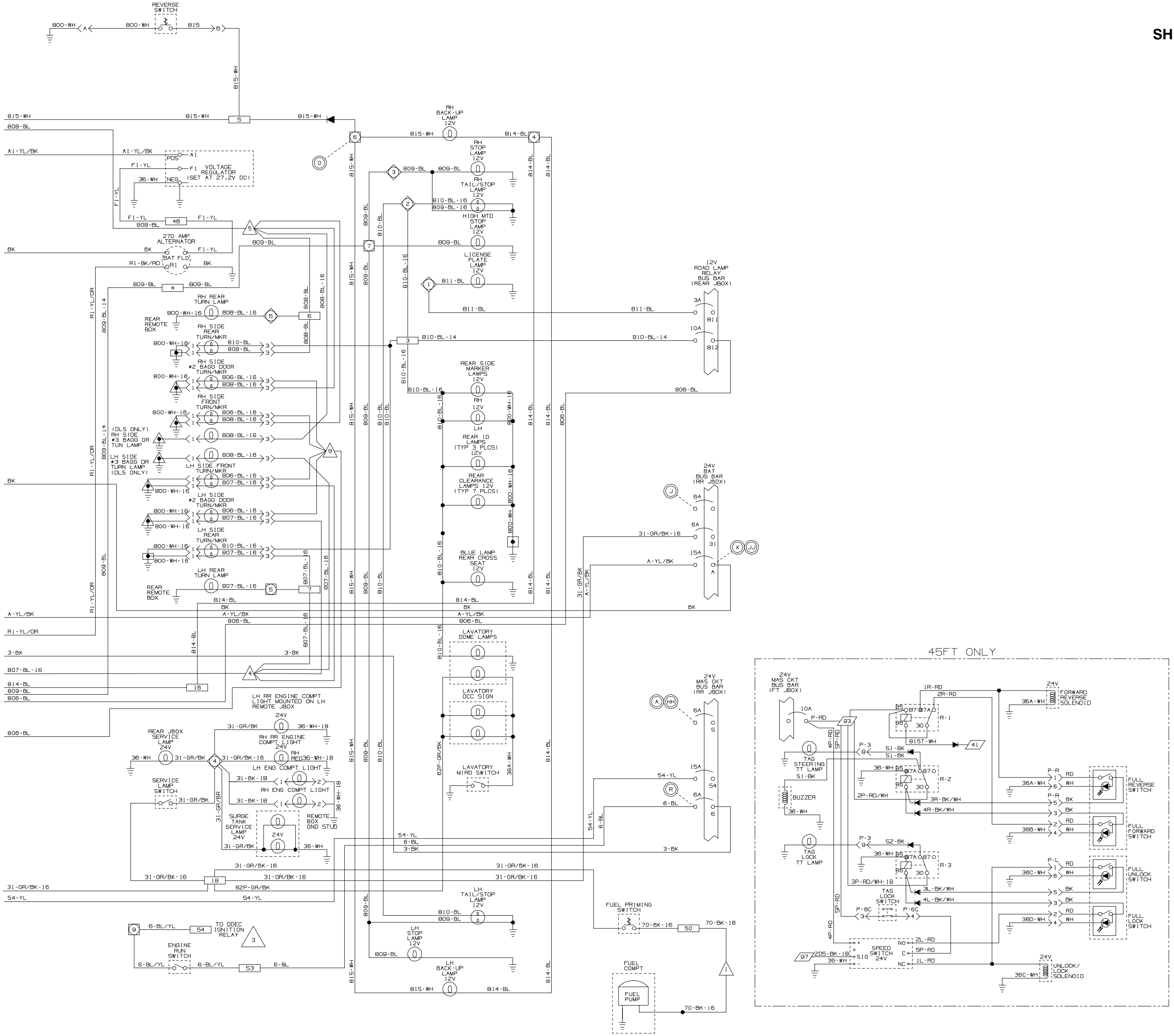
△4 CONNECT TO STUD 51 REAR J-BOX W/AIR CYLINDER A/C COMPRESSOR BELT TENSIONER OR TO GROUND STUD W/TURNBUCKLE TENSIONER.

SHEET 2 OF 3



HAZARD
PARK BRAKE
STOP LAMP
RH TURN SIG
STEP OUT
ABS
HI BEAM
HEATER ON
LOW FUEL
LOW AIR TAG AXLE
BACK-UP LAMP
PRESSURED AIR
COACH HEAT VALVE (ELECTRIC/PNUEMATIC)
TEMPERATURE CONTROLLER
AMBIENT THERMISTOR PICKUP PROBE (DRAG LINK COMPARTMENT)
THERMISTOR PICKUP PROBE (HEATER DUCT)
LOW FUEL SENSOR
TEST SIG
GND STUD (BACK OF DASH)
RECEPTICAL FOR EXTERIOR CORD
CONVERTER 110VAC TO 24VDC
DUPLEX OUTLET LH PARCEL RACK
BAGGAGE COMPARTMENT LAMP (TYP 6 PLCS) 110V 15W
BAGGAGE COMPARTMENT LAMP (TYP 6 PLCS) 24V
BAGGAGE COMPARTMENT LAMP SW (TYP 6 PLCS)
RH READING LAMP/SW (TYP 13 PLCS W/LAV) (TYP 15 PLCS W/O LAV)
OPENS ON RISE AT 425 PSI CLOSES ON FALL AT 300 PSI
OPENS ON FALL AT 6 PSI CLOSES ON RISE AT 25 PSI
TURN SIG CLAPPER
RH P/RACK
LOW OIL PRESSURE SWITCH N.C.
NEUTRAL SWITCH N.O.
FAST IDLE SWITCH
TO DDEC FAST IDLE RELAY
FAST IDLE RELAY
NEUTRAL RELAY
START SOLENOID
STARTER AND MOTOR
BOOSTER POST
TRIPLE FUNCTION PROTECTIVE DEVICE
3N-124
PASSENGER A/C (ON) RELAY
OVHD AISLE LAMP AT RH P/RACK (TYP 11 PLCS)
WINDOW LAMP AT RH P/RACK (TYP 8 PLCS)
LH PARCEL RACK #1
RH PARCEL RACK #2
PASSENGER A/C & HEAT SWITCH
LIQUID LINE SOLENOID VALVE (NC)
COMPRESSOR CLUTCH
CONDENSOR MOTOR M1
CONDENSOR MOTOR RELAY K1
FRT/REAR START SWITCH
FIELD RELAY
24 VOLT ENGINE CRADLE STUD
LOW AIR SWITCH OPENS ON FALL AT 75 ±10 PSI (482 KPa) CLOSES ON RISE AT 95 ±5 PSI (655 KPa)
CLOSES ON RISE @425 PSI (NO)
RELAY K-5
CONDENSOR MOTOR M2
COND MOTOR RELAY K-2
RELAY LC-1
2 SPEED EVAPORATOR MOTOR SUB ASSEMBLY
2 SPEED EVAPORATOR MOTOR
TYPE ISD N.O.
EVAPORATOR MOTOR RELAY
DRIVERS HI-LOW SWITCH
DISCHARGE AND BLOWER CUT-IN RELAY
NOT GEN T/T LAMP (REAR) 24V
LOW WATER
BATTERY 12V POWER
A/C MALFUNC
STARTER ALERT
NOT GEN
LH TURN SIG
LAMP TEST SIG GND
HOT ENG
LOW OIL
LOW AIR
CHECK ENG
STOP ENGINE
(+) 12V DC
TO DDEC ECM MODULE
WINDOW LAMP AT LH P/RACK (TYP 8 PLCS)
OVHD AISLE LAMP AT LH P/RACK (TYP 11 PLCS)
BATTERY MONITOR
BATT BALANCE
BATT HI
BATT LO
+24V
+12V
GND
+24V IGN
+24V BATT MON.
LH READING LAMP/SW (TYP 15 PLCS)
TO DDEC 11 STUD BLOCK (BAT COMPT)
BATTERY
VANNER
24V MAIN DISCONNECT SWITCH
12V MAIN DISCONNECT SWITCH
24V BAT BUS BAR (A/C JBOX)
LH P RACK
24V-BK
12V-BL

SHEET 3 OF 3


REVERSE SWITCH
800-WH
815
815-WH
808-BL
A1-YL/BK
F1-YL
36-WH
POS
NEG
VOLTAGE REGULATOR (SET AT 27.2V DC)
270 AMP ALTERNATOR
BAT FLD
R1-BK/RD
R1-YL/OR
BK
809-BL
RH BACK-UP LAMP 12V
814-BL
RH STOP LAMP 12V
RH TAIL/STOP LAMP 12V
810-BL-16
HIGH MTD STOP LAMP 12V
LICENSE PLATE LAMP 12V
811-BL
RH REAR TURN LAMP
REAR REMOTE BOX
800-WH-16
808-BL-16
RH SIDE REAR TURN/MKR
810-BL
808-BL
RH SIDE #2 BAGG DOOR TURN/MKR
806-BL-16
RH SIDE FRONT TURN/MKR
(DLS ONLY) RH SIDE #3 BAGG DR TUN LAMP
LH SIDE #3 BAGG DR TURN LAMP (DLS ONLY)
LH SIDE FRONT TURN/MKR
807-BL-16
LH SIDE #2 BAGG DOOR TURN/MKR
LH SIDE REAR TURN/MKR
LH REAR TURN LAMP
810-BL-14
809-BL-14
REAR SIDE MARKER LAMPS 12V
RH
LH
REAR ID LAMPS (TYP 3 PLCS) 12V
REAR CLEARANCE LAMPS 12V (TYP 7 PLCS)
BLUE LAMP REAR CROSS SEAT 12V
12V ROAD LAMP RELAY BUS BAR (REAR JBOX)
3A
10A
806-BL
24V BAT BUS BAR (RR JBOX)
6A
15A
31-GR/BK-16
A-YL/BK
3-BK
LAVATORY DOME LAMPS
LAVATORY OCC SIGN
LAVATORY MIRO SWITCH
36A-WH
62P-GR/BK
LH RR ENGINE COMPT LIGHT MOUNTED ON LH REMOTE JBOX
24V
31-GR/BK
36-WH-18
REAR JBOX SERVICE LAMP 24V
RH RR ENGINE COMPT LIGHT 24V
RH RED
LH ENG COMPT LIGHT
31-BK-18
RH ENG COMPT LIGHT
SERVICE LAMP SWITCH
31-GR/BR
SURGE TANK SERVICE LAMP 24V
REMOTE BOX GND STUD
54-YL
6-BL
24V MAS CKT BUS BAR (RR JBOX)
LH TAIL/STOP LAMP 12V
LH STOP LAMP 12V
LH BACK-UP LAMP 12V
6-BL/YL
TO DDEC IGNITION RELAY
ENGINE RUN SWITCH
FUEL PRIMING SWITCH
70-BK-16
FUEL COMPT
FUEL PUMP
45FT ONLY
24V MAS CKT BUS BAR (FT JBOX)
P-RD
1R-RD
2R-RD
36A-WH
FORWARD REVERSE SOLENOID
R-1
815T-WH
TAG STEERING TT LAMP
S1-BK
R-2
BUZZER
2P-RD/WH
3R-BK/WH
4R-BK/WH
FULL REVERSE SWITCH
36B-WH
FULL FORWARD SWITCH
TAG LOCK TT LAMP
S2-BK
R-3
3P-RD/WH-18
3L-BK/WH
4L-BK/WH
36C-WH
FULL UNLOCK SWITCH
TAG LOCK SWITCH
36D-WH
FULL LOCK SWITCH
4P-RD
5P-RD
205-BK-18
SPEED SWITCH 24V
NO
C
NC
SIG
2L-RD
1L-RD
UNLOCK/LOCK SOLENOID

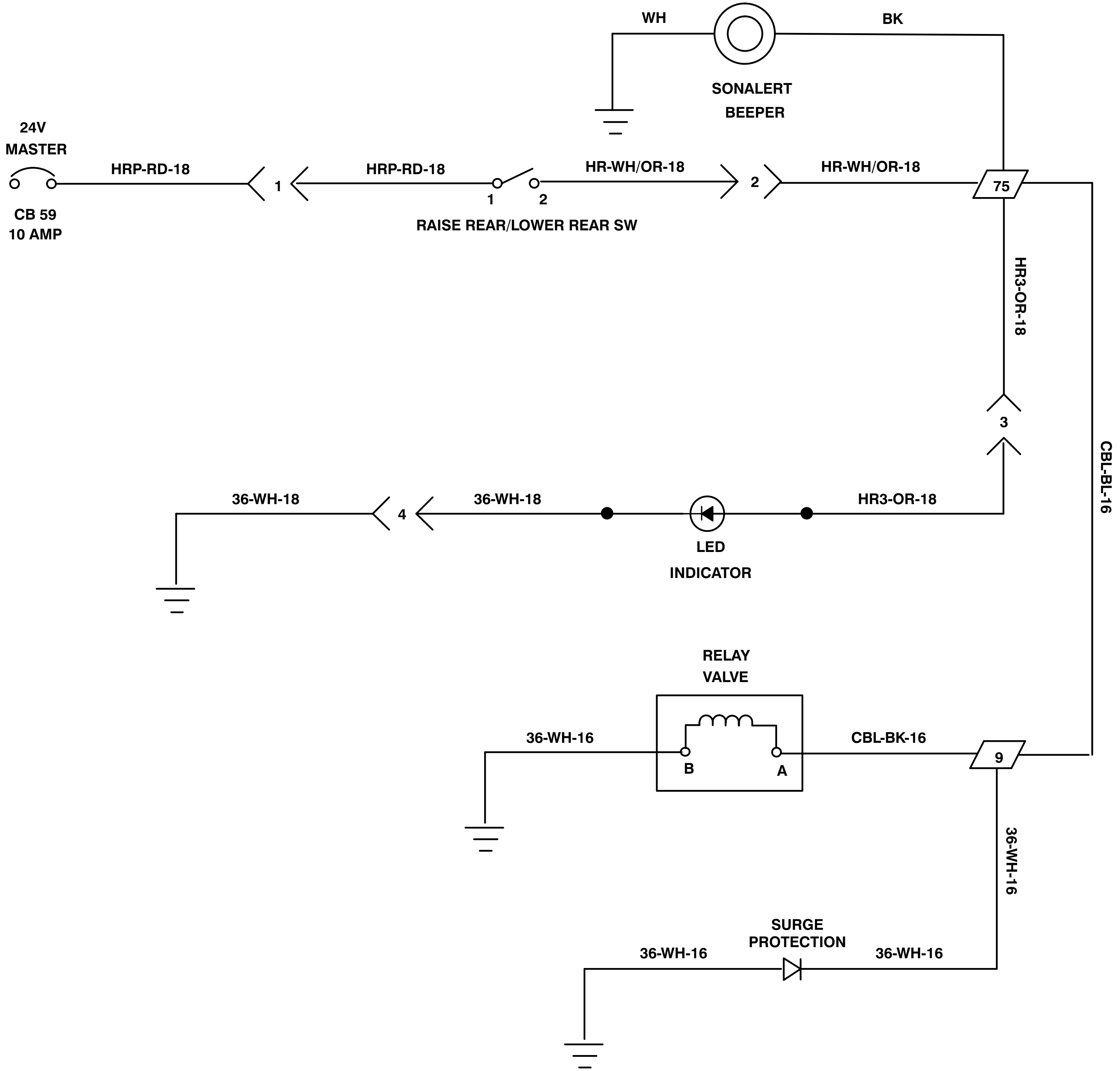
PART NO.	DESCRIPTION	REV.
7L-13-2112	REAR RISE FEATURE (MANUAL)	A

▱	FRT J−BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J−BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J−BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J−BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J−BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J−BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J−BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J−BOX VERT STUD BLK	— —	OPTION

WH−WHITE
GY−GREY
VO−VIOLET
BL−BLUE
GR−GREEN
YL−YELLOW
OR−ORANGE
RD−RED
BR−BROWN
BK−BLACK

LEGEND

REAR RISE FEATURE - MANUAL
102DL3 MODELS ONLY
7L-13-2112 (REV A)


WH
BK
SONALERT
BEEPER
24V
MASTER
HRP-RD-18
1
HRP-RD-18
1
2
HR-WH/OR-18
2
HR-WH/OR-18
75
CB 59
10 AMP
RAISE REAR/LOWER REAR SW
HR3-OR-18
3
CBL-BL-16
36-WH-18
4
36-WH-18
HR3-OR-18
LED
INDICATOR
RELAY
VALVE
36-WH-16
B
A
CBL-BK-16
9
36-WH-16
SURGE
PROTECTION
36-WH-16
36-WH-16

PART NO.	DESCRIPTION	REV.
7L-13-2146	INTERMITTENT WIPER SYSTEM	C

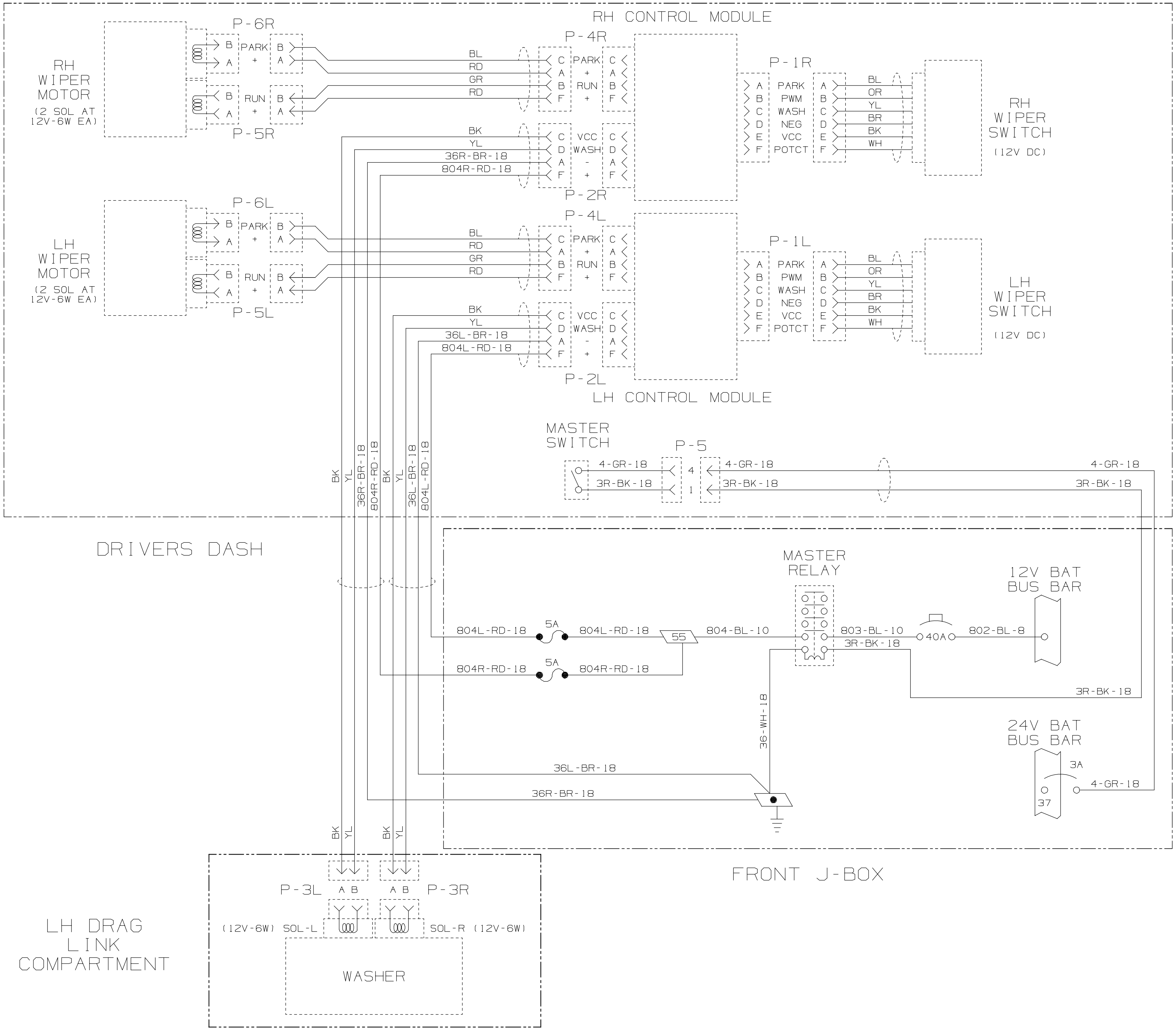
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

INTERMITTENT WIPER SYSTEM
102D3 & 102DL3 MODELS
7L-13-2146 (REV C)


RH CONTROL MODULE
RH WIPER MOTOR
(2 SOL AT 12V-6W EA)
P-6R
P-5R
P-4R
P-2R
P-1R
PARK +
RUN +
PARK + RUN +
VCC WASH - +
BL
RD
GR
RD
BK
YL
36R-BR-18
804R-RD-18
PARK PWM WASH NEG VCC POTCT
BL OR YL BR BK WH
RH WIPER SWITCH
(12V DC)
LH WIPER MOTOR
(2 SOL AT 12V-6W EA)
P-6L
P-5L
P-4L
P-2L
P-1L
36L-BR-18
804L-RD-18
LH WIPER SWITCH
(12V DC)
LH CONTROL MODULE
MASTER SWITCH
P-5
4-GR-18
3R-BK-18
DRIVERS DASH
MASTER RELAY
12V BAT BUS BAR
5A
55
804-BL-10
803-BL-10
40A
802-BL-8
36-WH-18
24V BAT BUS BAR
3A
37
FRONT J-BOX
P-3L
P-3R
A B
(12V-6W) SOL-L
SOL-R (12V-6W)
WASHER
LH DRAG LINK COMPARTMENT

PART NO.	DESCRIPTION	REV.
7L-13-2156	**BACKUP ALARM**	**A**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	– –	OPTION

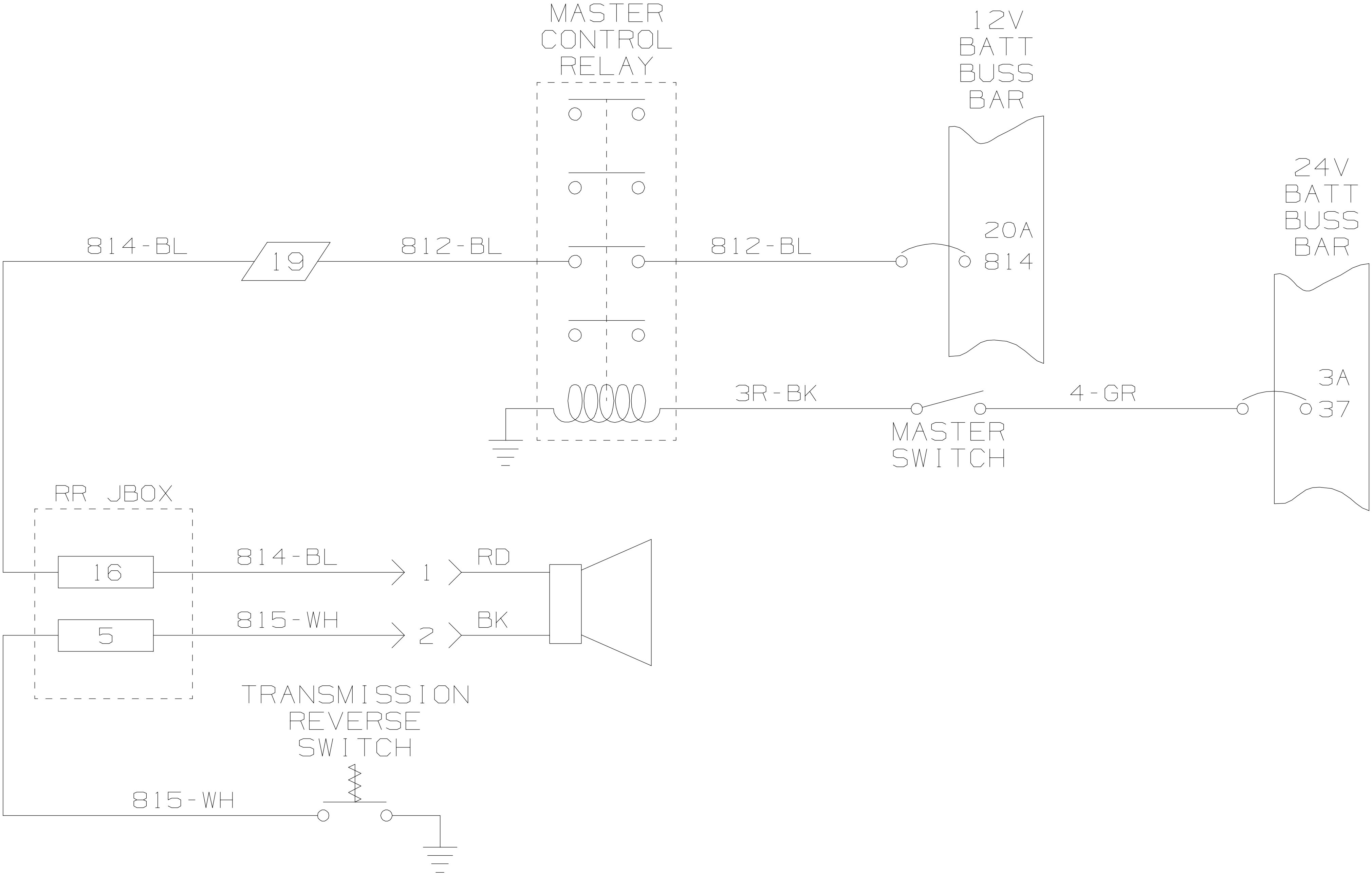
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

RD–RED
BR–BROWN
BK–BLACK

LEGEND

BACKUP ALARM
102D3 & 102DL3 MODELS
7L-13-2156 (REV A)


MASTER CONTROL RELAY
12V BATT BUSS BAR
24V BATT BUSS BAR
814-BL
19
812-BL
812-BL
20A
814
3R-BK
4-GR
3A
37
MASTER SWITCH
RR JBOX
16
814-BL
1
RD
5
815-WH
2
BK
TRANSMISSION REVERSE SWITCH
815-WH

PART NO.	DESCRIPTION	REV.
7L-13-2208	ENTRANCE DOOR (BI-PART)	A

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⍍	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE

GR–GREEN
YL–YELLOW
OR–ORANGE

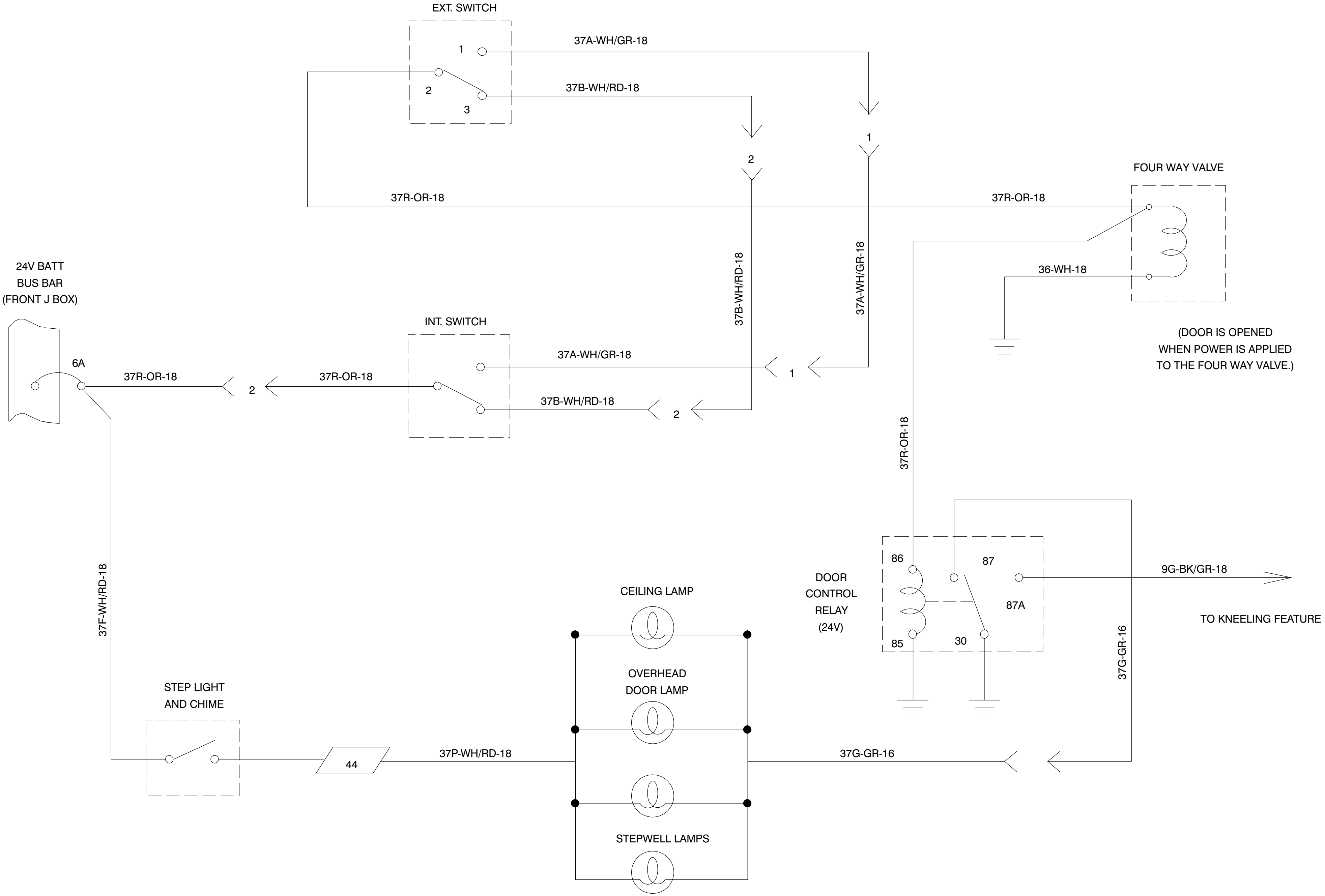
RD–RED
BR–BROWN
BK–BLACK

LEGEND

AIR OPERATED ENTRANCE DOOR (BI-PART DOOR)

102D3 & 102DL3 MODELS

7L-13-2208 (REV A)


EXT. SWITCH
1
2
3
37A-WH/GR-18
37B-WH/RD-18
1
2
FOUR WAY VALVE
37R-OR-18
37R-OR-18
36-WH-18
37B-WH/RD-18
37A-WH/GR-18
24V BATT
BUS BAR
(FRONT J BOX)
6A
INT. SWITCH
37R-OR-18
2
37R-OR-18
37A-WH/GR-18
1
37B-WH/RD-18
2
(DOOR IS OPENED
WHEN POWER IS APPLIED
TO THE FOUR WAY VALVE.)
37R-OR-18
DOOR
CONTROL
RELAY
(24V)
86
87
87A
85
30
9G-BK/GR-18
TO KNEELING FEATURE
37F-WH/RD-18
CEILING LAMP
OVERHEAD
DOOR LAMP
37G-GR-16
STEP LIGHT
AND CHIME
44
37P-WH/RD-18
37G-GR-16
STEPWELL LAMPS

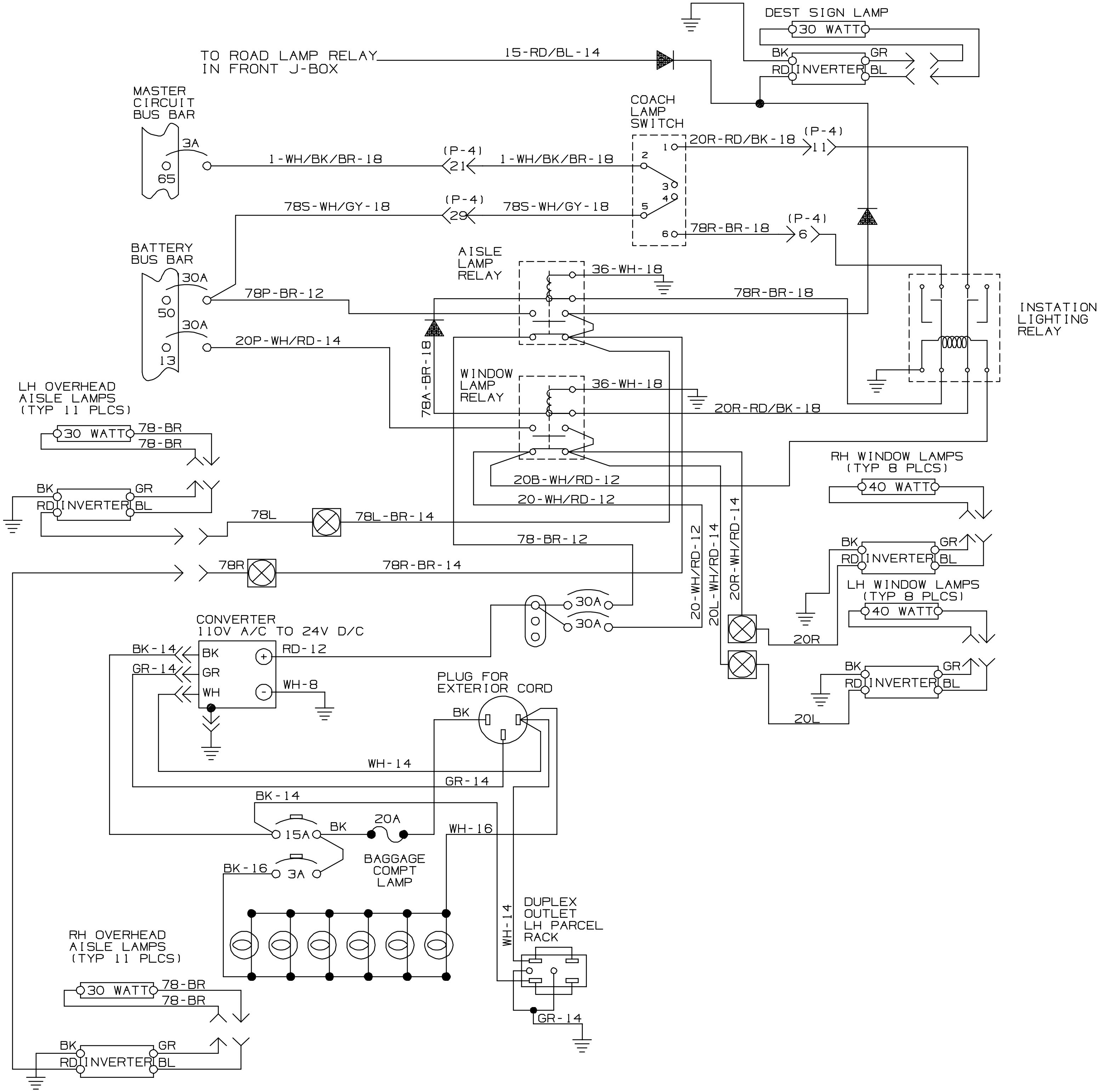
PART NO.	DESCRIPTION	REV.
7L-13-2229	IN-STATION LIGHTING	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

IN–STATION LIGHTING
102D3 & 102DL3
7L–13–2229 (REV A)


DEST SIGN LAMP
30 WATT
BK
GR
RD
INVERTER
BL
TO ROAD LAMP RELAY
IN FRONT J-BOX
15-RD/BL-14
MASTER
CIRCUIT
BUS BAR
3A
65
1-WH/BK/BR-18
(P-4)
21
1-WH/BK/BR-18
COACH
LAMP
SWITCH
20R-RD/BK-18
(P-4)
11
78S-WH/GY-18
(P-4)
29
78S-WH/GY-18
78R-BR-18
(P-4)
6
BATTERY
BUS BAR
30A
50
30A
13
78P-BR-12
20P-WH/RD-14
AISLE
LAMP
RELAY
36-WH-18
78R-BR-18
INSTATION
LIGHTING
RELAY
78A-BR-18
WINDOW
LAMP
RELAY
36-WH-18
20R-RD/BK-18
LH OVERHEAD
AISLE LAMPS
(TYP 11 PLCS)
30 WATT
78-BR
78-BR
BK
GR
RD
INVERTER
BL
20B-WH/RD-12
20-WH/RD-12
RH WINDOW LAMPS
(TYP 8 PLCS)
40 WATT
78L
78L-BR-14
78-BR-12
78R
78R-BR-14
20-WH/RD-12
20L-WH/RD-14
20R-WH/RD-14
BK
GR
RD
INVERTER
BL
LH WINDOW LAMPS
(TYP 8 PLCS)
40 WATT
30A
30A
20R
CONVERTER
110V A/C TO 24V D/C
BK-14
BK
GR-14
GR
WH
+
RD-12
-
WH-8
BK
GR
RD
INVERTER
BL
20L
PLUG FOR
EXTERIOR CORD
BK
WH-14
GR-14
BK-14
15A
BK
20A
WH-16
BAGGAGE
COMPT
LAMP
BK-16
3A
DUPLEX
OUTLET
LH PARCEL
RACK
WH-14
GR-14
RH OVERHEAD
AISLE LAMPS
(TYP 11 PLCS)
30 WATT
78-BR
78-BR
BK
GR
RD
INVERTER
BL

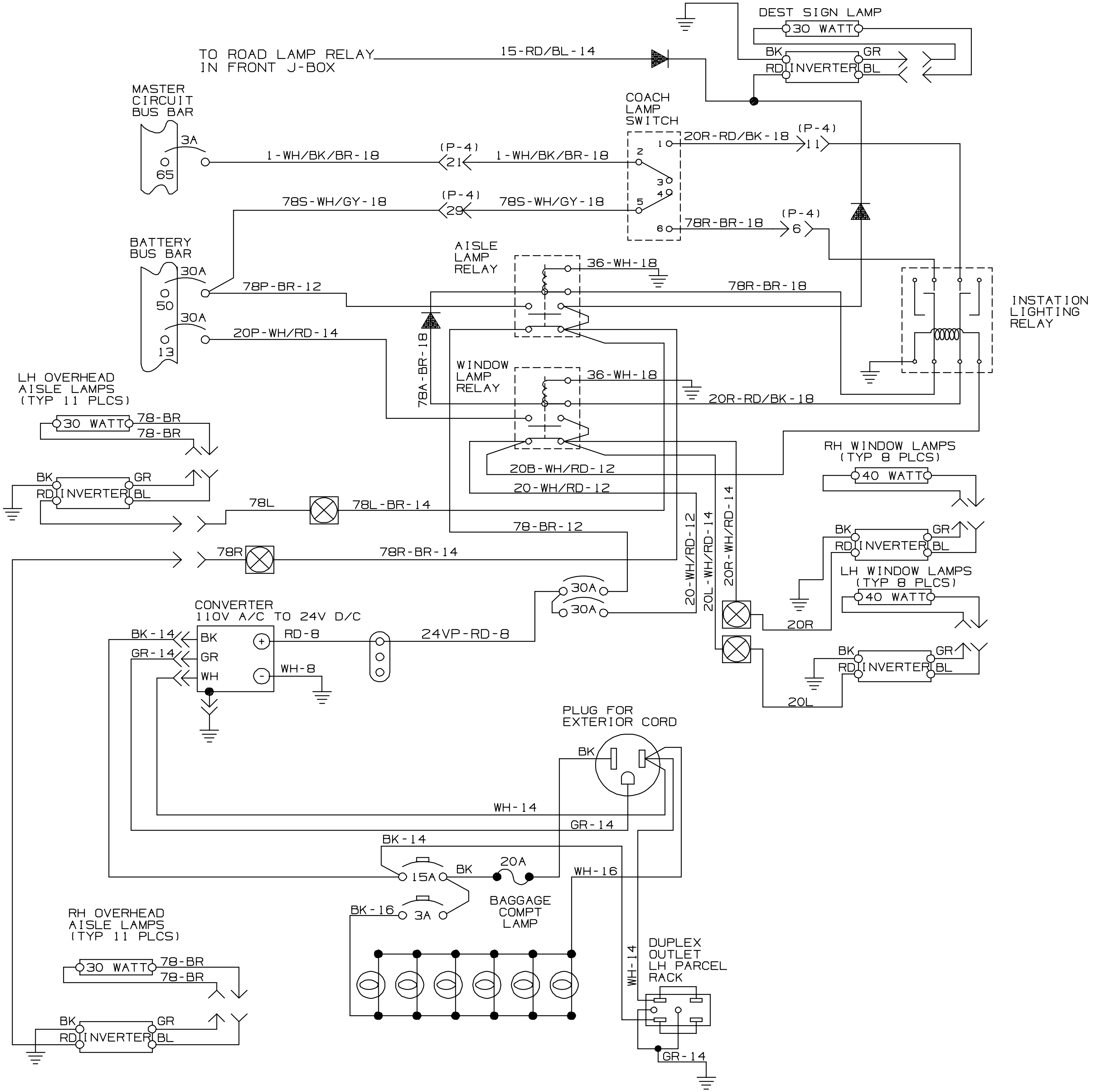
PART NO.	DESCRIPTION	REV.
7L-13-2322	IN-STATION LIGHTING	A

▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE	RD—RED
GY—GREY	BR—BROWN
VO—VIOLET	BK—BLACK
BL—BLUE	YL—YELLOW
GR—GREEN	OR—ORANGE

LEGEND

IN—STATION LIGHTING
102D3 & 102DL3
7L—13—2322 (REV A)


DEST SIGN LAMP
30 WATT
BK
GR
RD
INVERTER
BL
TO ROAD LAMP RELAY
IN FRONT J-BOX
15-RD/BL-14
MASTER
CIRCUIT
BUS BAR
3A
65
COACH
LAMP
SWITCH
20R-RD/BK-18
(P-4)
11
1-WH/BK/BR-18
(P-4)
21
1-WH/BK/BR-18
1
2
3
4
5
6
78S-WH/GY-18
(P-4)
29
78S-WH/GY-18
78R-BR-18
(P-4)
6
BATTERY
BUS BAR
30A
50
30A
13
AISLE
LAMP
RELAY
36-WH-18
78P-BR-12
78R-BR-18
20P-WH/RD-14
INSTATION
LIGHTING
RELAY
78A-BR-18
WINDOW
LAMP
RELAY
36-WH-18
20R-RD/BK-18
LH OVERHEAD
AISLE LAMPS
(TYP 11 PLCS)
30 WATT
78-BR
78-BR
BK
GR
RD
INVERTER
BL
20B-WH/RD-12
20-WH/RD-12
RH WINDOW LAMPS
(TYP 8 PLCS)
40 WATT
78L
78L-BR-14
78-BR-12
BK
GR
RD
INVERTER
BL
78R
78R-BR-14
20-WH/RD-12
20L-WH/RD-14
20R-WH/RD-14
LH WINDOW LAMPS
(TYP 8 PLCS)
40 WATT
30A
30A
CONVERTER
110V A/C TO 24V D/C
BK-14
BK
GR-14
GR
WH
RD-8
24VP-RD-8
20R
WH-8
BK
GR
RD
INVERTER
BL
20L
PLUG FOR
EXTERIOR CORD
BK
WH-14
GR-14
BK-14
15A
BK
20A
WH-16
BK-16
3A
BAGGAGE
COMPT
LAMP
RH OVERHEAD
AISLE LAMPS
(TYP 11 PLCS)
30 WATT
78-BR
78-BR
WH-14
DUPLEX
OUTLET
LH PARCEL
RACK
BK
GR
RD
INVERTER
BL
GR-14

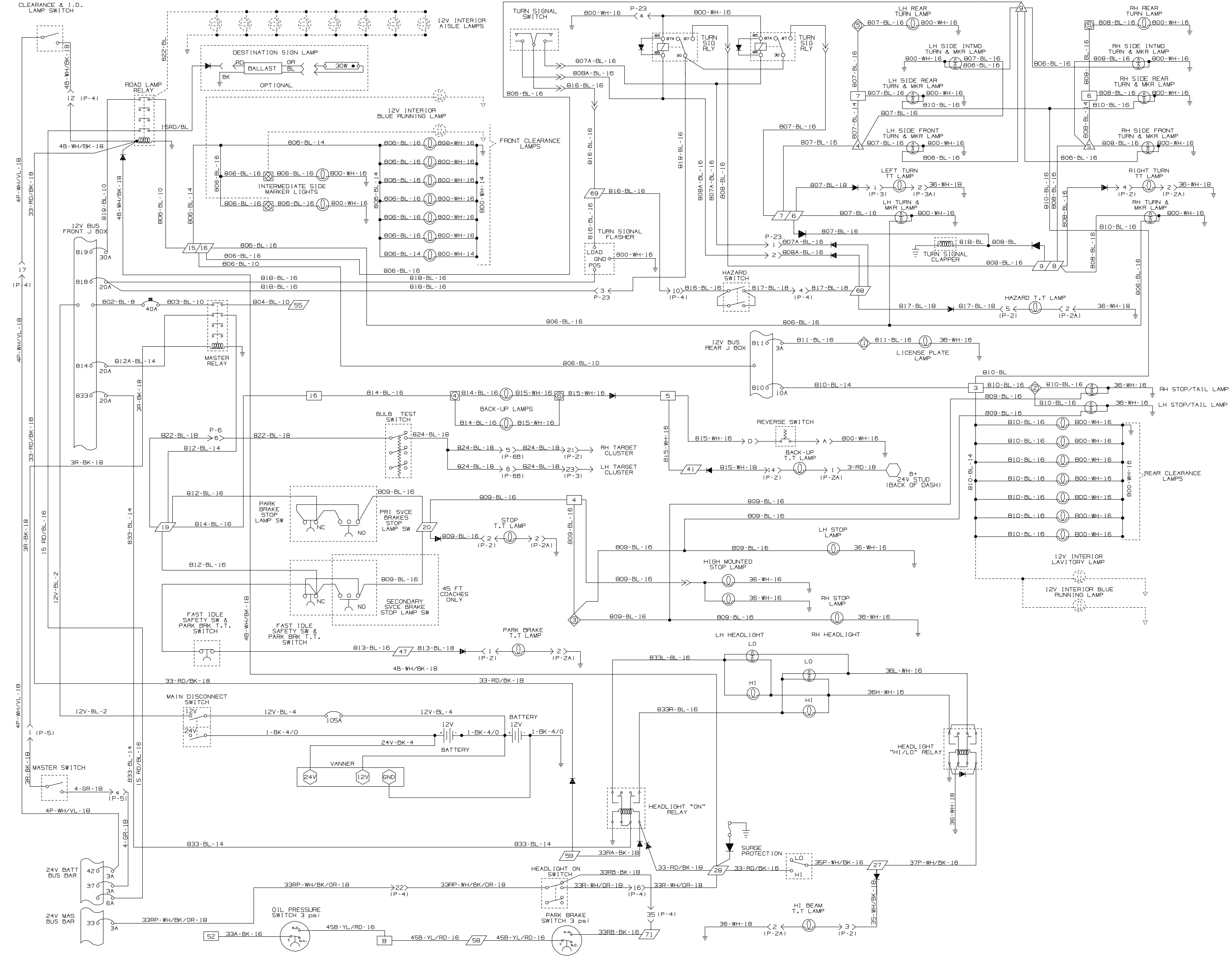
PART NO.	DESCRIPTION	REV.
7L-13-2386	EXTERIOR COACH LIGHTING	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

EXTERIOR COACH LIGHTING
HEADLAMPS, SIDE MARKER/TURN SIGNAL &
CLEARANCE/IDENTIFICATION LAMPS
W/DAYTIME RUNNING LIGHTS
102D3 & 102DL3 MODELS
7L-13-2386 (REV A)


CLEARANCE & I.D. LAMP SWITCH
12V INTERIOR AISLE LAMPS
DESTINATION SIGN LAMP
BALLAST
30W
OPTIONAL
ROAD LAMP RELAY
12V INTERIOR BLUE RUNNING LAMP
FRONT CLEARANCE LAMPS
INTERMEDIATE SIDE MARKER LIGHTS
12V BUS FRONT J BOX
TURN SIGNAL SWITCH
TURN SIG RLY
TURN SIG RLY
TURN SIGNAL FLASHER
LOAD
GND
POS
HAZARD SWITCH
LH REAR TURN LAMP
LH SIDE INTMD TURN & MKR LAMP
LH SIDE REAR TURN & MKR LAMP
LH SIDE FRONT TURN & MKR LAMP
LEFT TURN TT LAMP
LH TURN & MKR LAMP
RH REAR TURN LAMP
RH SIDE INTMD TURN & MKR LAMP
RH SIDE REAR TURN & MKR LAMP
RH SIDE FRONT TURN & MKR LAMP
RIGHT TURN TT LAMP
RH TURN & MKR LAMP
TURN SIGNAL CLAPPER
HAZARD T.T LAMP
MASTER RELAY
12V BUS REAR J BOX
LICENSE PLATE LAMP
RH STOP/TAIL LAMP
LH STOP/TAIL LAMP
BACK-UP LAMPS
BULB TEST SWITCH
RH TARGET CLUSTER
LH TARGET CLUSTER
REVERSE SWITCH
BACK-UP T.T LAMP
B+ 24V STUD (BACK OF DASH)
REAR CLEARANCE LAMPS
PARK BRAKE STOP LAMP SW
PRI SVCE BRAKES STOP LAMP SW
NC
NO
STOP T.T LAMP
SECONDARY SVCE BRAKE STOP LAMP SW
45 FT COACHES ONLY
LH STOP LAMP
HIGH MOUNTED STOP LAMP
RH STOP LAMP
12V INTERIOR LAVITORY LAMP
12V INTERIOR BLUE RUNNING LAMP
FAST IDLE SAFETY SW & PARK BRK T.T. SWITCH
FAST IDLE SAFETY SW & PARK BRK T.T. SWITCH
PARK BRAKE T.T LAMP
LH HEADLIGHT
RH HEADLIGHT
LO
HI
MAIN DISCONNECT SWITCH
12V
24V
105A
BATTERY
BATTERY
VANNER
24V
12V
GND
HEADLIGHT "HI/LO" RELAY
MASTER SWITCH
HEADLIGHT "ON" RELAY
SURGE PROTECTION
24V BATT BUS BAR
24V MAS BUS BAR
HEADLIGHT ON SWITCH
OIL PRESSURE SWITCH 3 psi
PARK BRAKE SWITCH 3 psi
HI BEAM T.T LAMP
806-BL-16
800-WH-16
807-BL-16
808-BL-16
809-BL-16
810-BL-16
814-BL-16
815-WH-16
816-BL-16
817-BL-18
818-BL-16
822-BL-18
824-BL-18
833-BL-14
33-RD/BK-18
4P-WH/VL-18
4B-WH/BK-18
3R-BK-18
12V-BL-2
12V-BL-4
1-BK-4/0
24V-BK-4
4-GR-18
33RP-WH/BK/OR-18
45B-YL/RD-16
33A-BK-16
33RB-BK-18
36-WH-18
36-WH-16
36L-WH-16
36H-WH-16
35P-WH/BK-16
37P-WH/BK-18
P-23
P-4
P-5
P-6
P-2
P-2A
P-3
P-3A
P-6B

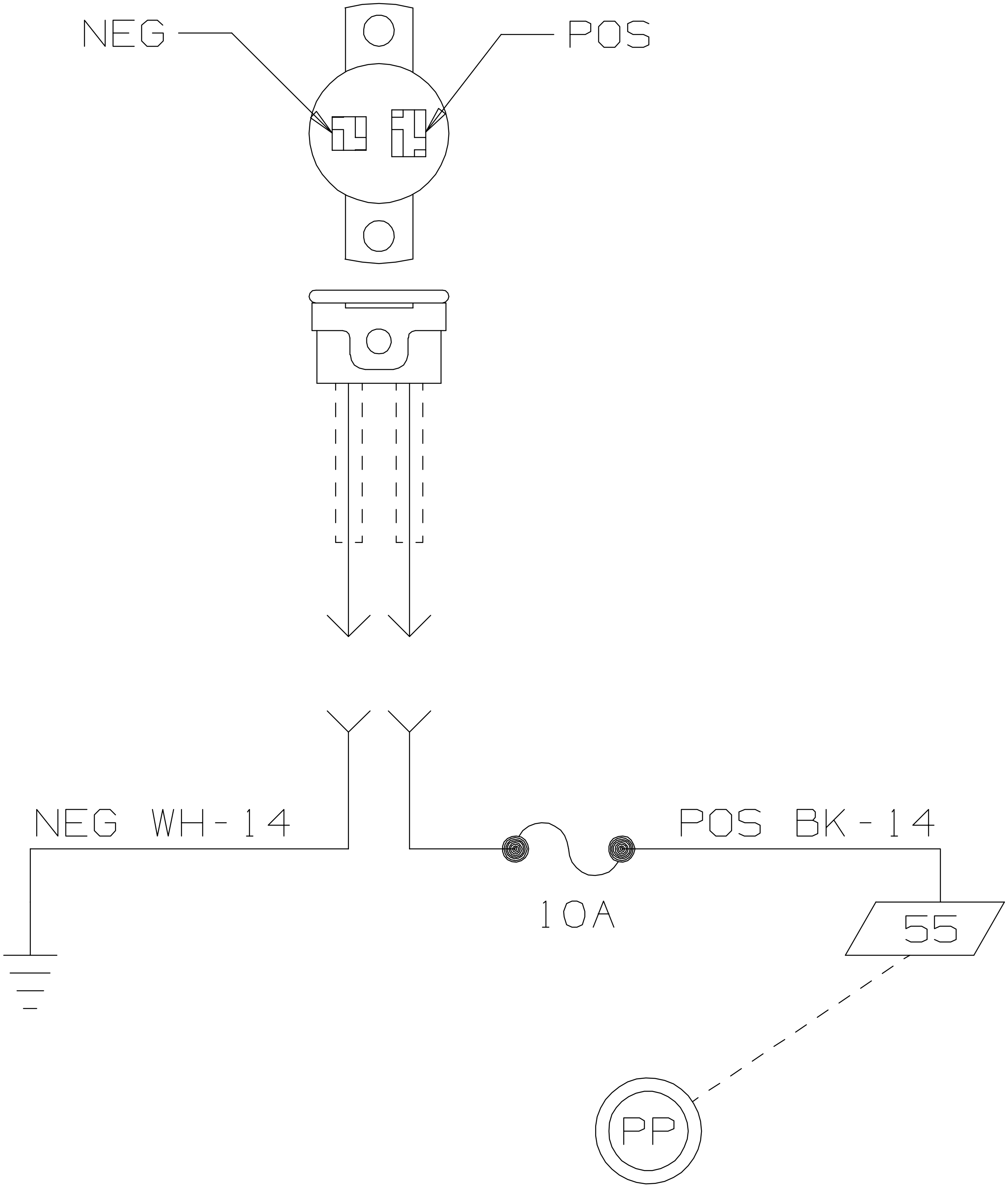
PART NO.	DESCRIPTION	REV.
7L-13-2447	12V POWER SOURCE	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

12V POWER SOURCE
102D3 & 102DL3
7L–13–2447 (REV A)


NEG
POS
NEG WH-14
POS BK-14
10A
55
PP

PART NO.	DESCRIPTION	REV.
7L-13-2570	ENTERTAINMENT SYSTEM	D

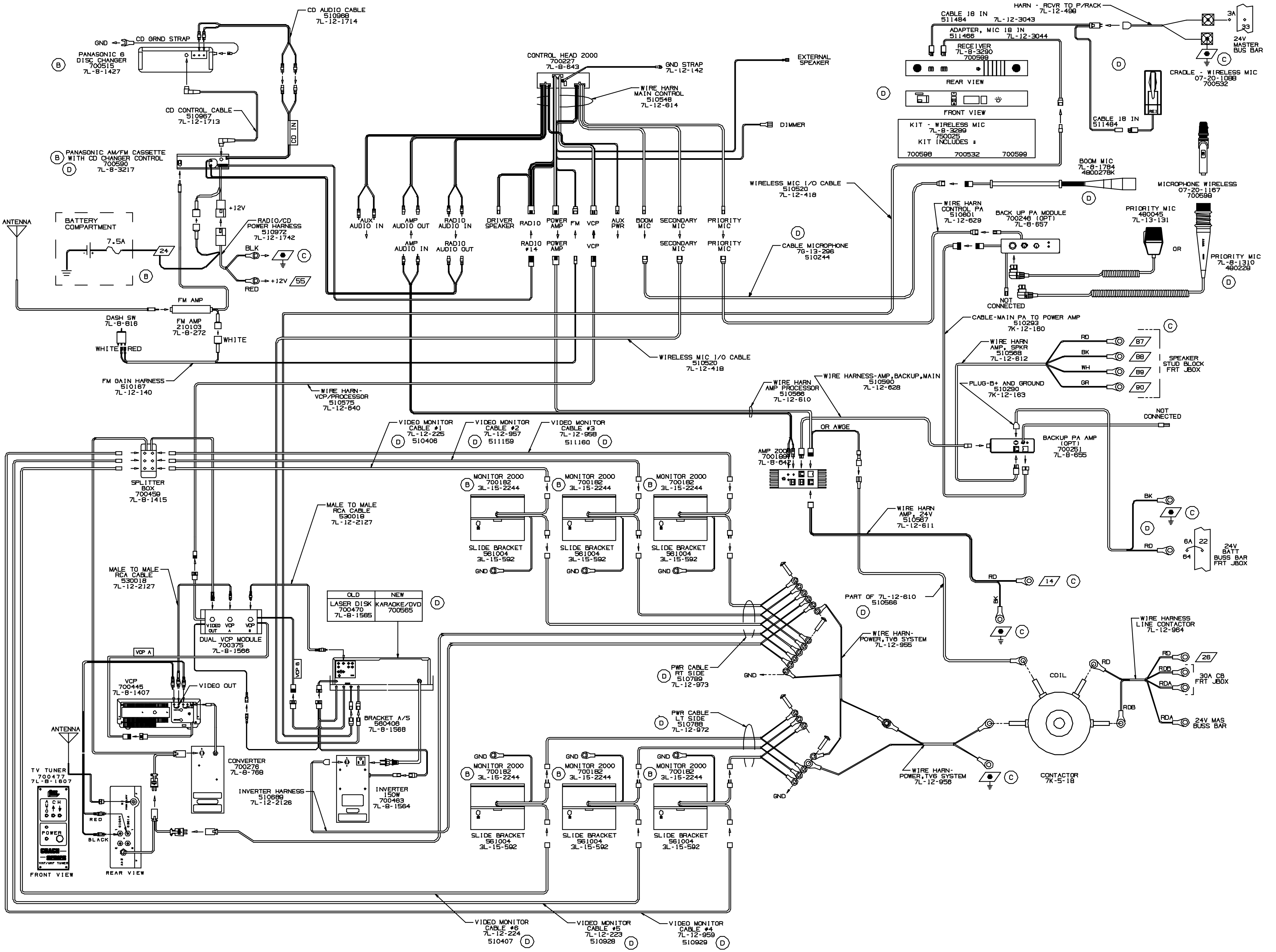
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
⧇	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

2000 ENTERTAINMENT SYSTEM
102D & 102DL3
7L–13–2570 (REV D)



CD AUDIO CABLE
510968
7L-12-1714
GND
CD GRND STRAP
PANASONIC 6
DISC CHANGER
700515
7L-8-1427
B
CD CONTROL CABLE
510967
7L-12-1713
CD IN
PANASONIC AM/FM CASSETTE
WITH CD CHANGER CONTROL
700590
7L-8-3217
B
D
+12V
RADIO/CD
POWER HARNESS
510972
7L-12-1742
BLK
RED
+12V
55
C
ANTENNA
BATTERY
COMPARTMENT
7.5A
24
B
FM AMP
FM AMP
210103
7L-8-272
DASH SW
7L-8-816
WHITE
RED
WHITE
FM GAIN HARNESS
510167
7L-12-140
CONTROL HEAD 2000
700227
7L-8-643
GND STRAP
7L-12-142
EXTERNAL
SPEAKER
WIRE HARN
MAIN CONTROL
510548
7L-12-614
DIMMER
AUX
AUDIO IN
AMP
AUDIO OUT
RADIO
AUDIO IN
DRIVER
SPEAKER
RADIO
POWER
AMP
FM
VCP
AUX
PWR
BOOM
MIC
SECONDARY
MIC
PRIORITY
MIC
AMP
AUDIO IN
RADIO
AUDIO OUT
RADIO
#14
POWER
AMP
VCP
SECONDARY
MIC
PRIORITY
MIC
WIRELESS MIC I/O CABLE
510520
7L-12-418
WIRE HARN-
VCP/PROCESSOR
510575
7L-12-640
HARN - RCVR TO P/RACK
7L-12-498
CABLE 18 IN
511484
7L-12-3043
ADAPTER, MIC 18 IN
511466
7L-12-3044
RECEIVER
7L-8-3290
700599
REAR VIEW
FRONT VIEW
D
KIT - WIRELESS MIC
7L-8-3289
750025
KIT INCLUDES :
700598
700532
700599
3A
33
24V
MASTER
BUS BAR
C
D
CRADLE - WIRELESS MIC
07-20-1088
700532
CABLE 18 IN
511484
BOOM MIC
7L-8-1784
480027BK
D
MICROPHONE WIRELESS
07-20-1167
700598
WIRELESS MIC I/O CABLE
510520
7L-12-418
WIRE HARN
CONTROL PA
510601
7L-12-629
BACK UP PA MODULE
700246 (OPT)
7L-8-657
PRIORITY MIC
480045
7L-13-131
OR
PRIORITY MIC
7L-8-1310
480228
D
D
CABLE MICROPHONE
7G-13-296
510244
NOT
CONNECTED
CABLE-MAIN PA TO POWER AMP
510293
7K-12-160
C
WIRE HARN
AMP, SPKR
510568
7L-12-612
RD
BK
WH
GR
87
88
89
90
SPEAKER
STUD BLOCK
FRT JBOX
PLUG-B+ AND GROUND
510290
7K-12-163
WIRE HARN
AMP PROCESSOR
510566
7L-12-610
WIRE HARNESS-AMP,BACKUP,MAIN
510590
7L-12-628
NOT
CONNECTED
OR AWGE
AMP 2000
700189
7L-8-642
BACKUP PA AMP
(OPT)
700251
7L-8-655
VIDEO MONITOR
CABLE #1
7L-12-225
510406
D
VIDEO MONITOR
CABLE #2
7L-12-957
511159
D
VIDEO MONITOR
CABLE #3
7L-12-958
511160
D
SPLITTER
BOX
700459
7L-8-1415
MONITOR 2000
700182
3L-15-2244
B
SLIDE BRACKET
561004
3L-15-592
GND
WIRE HARN
AMP, 24V
510567
7L-12-611
BK
C
D
RD
6A
22
64
24V
BATT
BUSS BAR
FRT JBOX
RD
14
C
BK
C
MALE TO MALE
RCA CABLE
530018
7L-12-2127
MALE TO MALE
RCA CABLE
530018
7L-12-2127
OLD
NEW
LASER DISK
700470
7L-8-1565
KARAOKE/DVD
700565
D
PART OF 7L-12-610
510566
D
VIDEO
OUT
VCP
A
VCP
B
DUAL VCP MODULE
700375
7L-8-1566
VCP A
VCP B
VCP
700445
7L-8-1407
VIDEO OUT
BRACKET A/S
560406
7L-8-1568
WIRE HARN-
POWER,TV6 SYSTEM
7L-12-955
PWR CABLE
RT SIDE
510789
7L-12-973
D
GND
WIRE HARNESS
LINE CONTACTOR
7L-12-964
RD
RDB
RDA
26
30A CB
FRT JBOX
COIL
RD
RDB
RDA
24V MAS
BUSS BAR
ANTENNA
CONVERTER
700276
7L-8-768
PWR CABLE
LT SIDE
510788
7L-12-972
D
INVERTER HARNESS
510689
7L-12-2126
INVERTER
150W
700463
7L-8-1564
TV TUNER
700477
7L-8-1607
CH
POWER
RED
BLACK
FRONT VIEW
REAR VIEW
GND
WIRE HARN-
POWER,TV6 SYSTEM
7L-12-956
C
CONTACTOR
7K-5-18
VIDEO MONITOR
CABLE #6
7L-12-224
510407
D
VIDEO MONITOR
CABLE #5
7L-12-223
510928
D
VIDEO MONITOR
CABLE #4
7L-12-959
510929
D

PART NO.	DESCRIPTION	REV.
7L-13-2658	KNEELING FEATURE	B

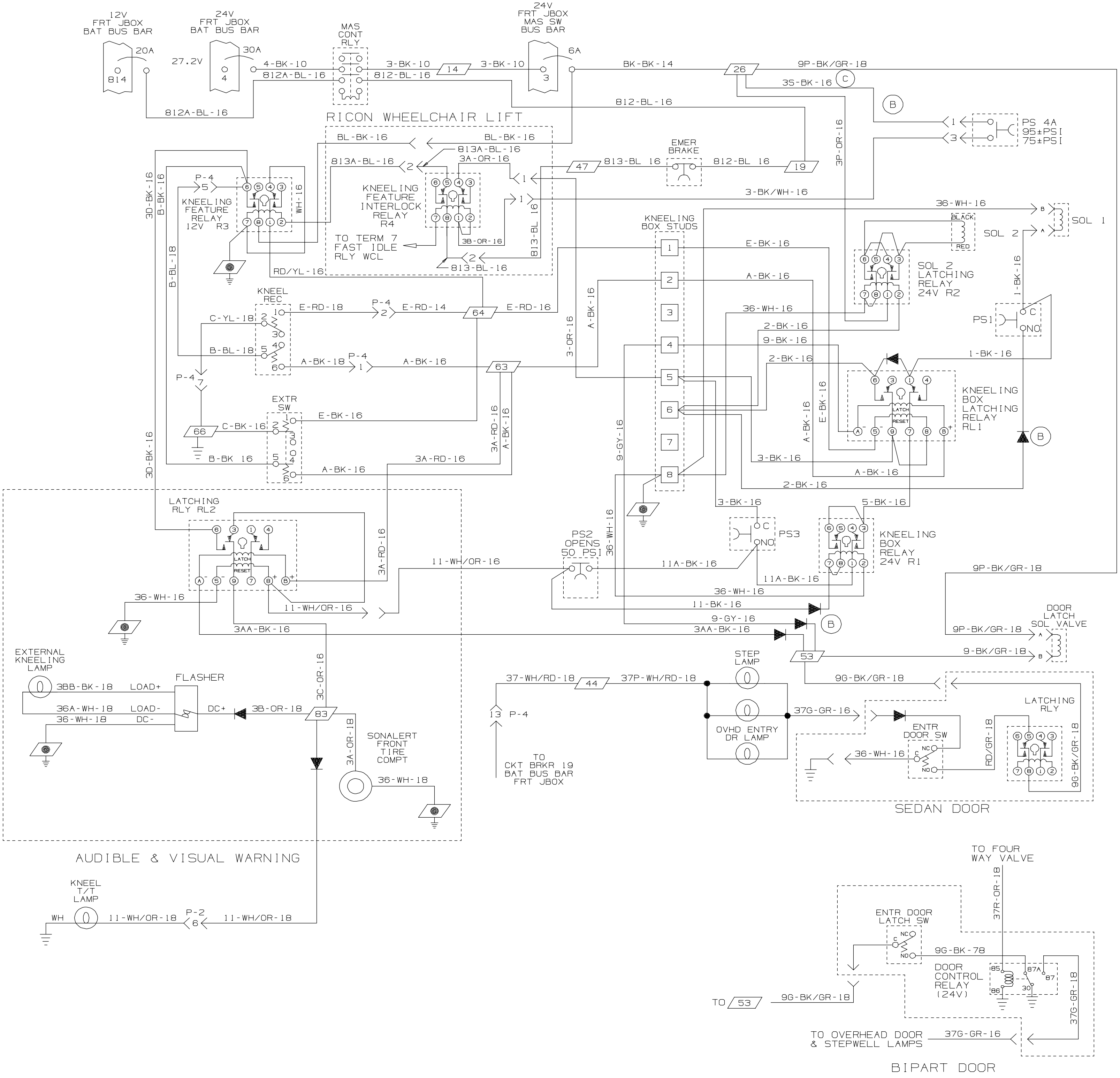
▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE
GR—GREEN

RD—RED
BR—BROWN
BK—BLACK
YL—YELLOW
OR—ORANGE

LEGEND

KNEELING FEATURE (W/RICON AND BI-PART
102D3 & 102DL3 MODELS
7L-13-2658 (REV B)



12V FRT JBOX BAT BUS BAR
814
20A
812A-BL-16
24V FRT JBOX BAT BUS BAR
27.2V
30A
4
4-BK-10
812A-BL-16
MAS CONT RLY
3-BK-10
812-BL-16
14
24V FRT JBOX MAS SW BUS BAR
6A
3
BK-BK-14
26
9P-BK/GR-18
3S-BK-16
C
B
812-BL-16
PS 4A
95±PSI
75±PSI
1
3
RICON WHEELCHAIR LIFT
BL-BK-16
813A-BL-16
3A-OR-16
47
813-BL 16
EMER BRAKE
812-BL 16
19
3P-OR-16
3-BK/WH-16
P-4
5
KNEELING FEATURE RELAY 12V R3
WH-16
KNEELING FEATURE INTERLOCK RELAY R4
3B-OR-16
813-BL 16
TO TERM 7 FAST IDLE RLY WCL
813-BL-16
3D-BK-16
B-BK-16
B-BL-18
RD/YL-16
36-WH-16
SOL 1
BLACK
RED
SOL 2
SOL 2 LATCHING RELAY 24V R2
1-BK-16
KNEELING BOX STUDS
E-BK-16
A-BK-16
36-WH-16
2-BK-16
9-BK-16
2-BK-16
1-BK-16
PS1
C
NO
KNEEL REC
E-RD-18
P-4
2
E-RD-14
64
E-RD-16
C-YL-18
B-BL-18
A-BK-18
A-BK-16
63
3-OR-16
A-BK-16
KNEELING BOX LATCHING RELAY RL1
LATCH
RESET
A-BK-16
E-BK-16
3-BK-16
A-BK-16
2-BK-16
B
P-4
7
EXTR SW
E-BK-16
66
C-BK-16
B-BK 16
A-BK-16
3A-RD-16
3A-RD-16
A-BK-16
9-GY-16
36-WH-16
LATCHING RLY RL2
3A-RD-16
11-WH/OR-16
PS2 OPENS 50 PSI
11A-BK-16
3-BK-16
PS3
5-BK-16
KNEELING BOX RELAY 24V R1
11A-BK-16
36-WH-16
11-BK-16
9-GY-16
3AA-BK-16
B
9P-BK/GR-18
DOOR LATCH SOL VALVE
9P-BK/GR-18
9-BK/GR-18
53
9G-BK/GR-18
36-WH-16
11-WH/OR-16
3AA-BK-16
3C-OR-16
EXTERNAL KNEELING LAMP
3BB-BK-18
LOAD+
FLASHER
36A-WH-18
LOAD-
DC+
3B-OR-18
83
36-WH-18
DC-
3A-OR-18
SONALERT FRONT TIRE COMPT
36-WH-18
37-WH/RD-18
44
37P-WH/RD-18
STEP LAMP
13 P-4
TO CKT BRKR 19 BAT BUS BAR FRT JBOX
37G-GR-16
OVHD ENTRY DR LAMP
ENTR DOOR SW
36-WH-16
NC
C
NO
RD/GR-18
LATCHING RLY
9G-BK/GR-18
SEDAN DOOR
AUDIBLE & VISUAL WARNING
KNEEL T/T LAMP
WH
11-WH/OR-18
P-2
6
11-WH/OR-18
TO FOUR WAY VALVE
37R-OR-18
ENTR DOOR LATCH SW
9G-BK-78
DOOR CONTROL RELAY (24V)
85
86
87A
87
30
37G-GR-18
TO 53
9G-BK/GR-18
TO OVERHEAD DOOR & STEPWELL LAMPS
37G-GR-16
BIPART DOOR

PART NO.	DESCRIPTION	REV.
7L-13-2702	READING LIGHTS	A

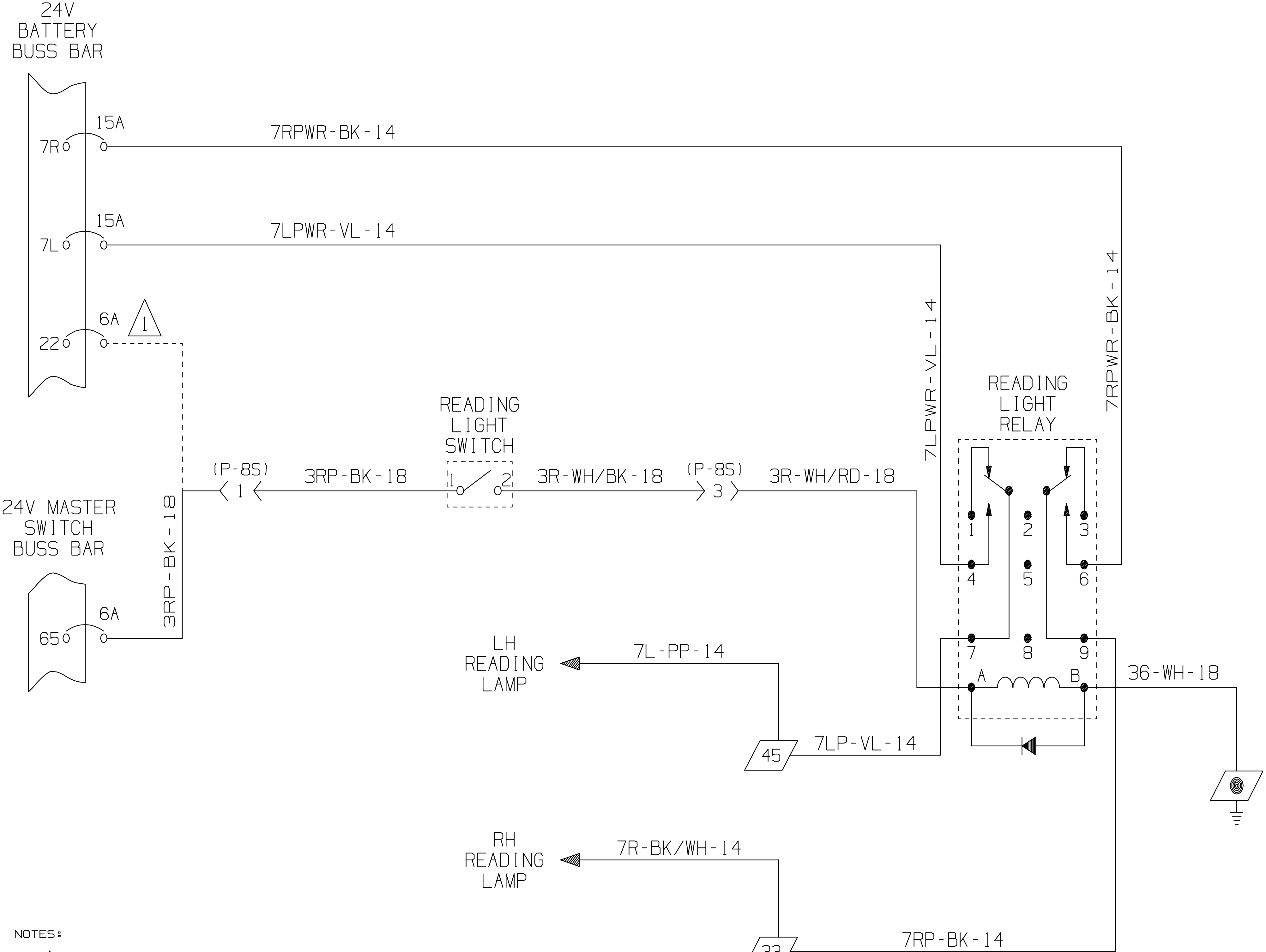
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
◻	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⊠	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

READING LIGHTS
102D3 & 102DL3
7L–13–2702 (REV A)


24V BATTERY BUSS BAR
7R
15A
7RPWR-BK-14
7L
15A
7LPWR-VL-14
22
6A
1
24V MASTER SWITCH BUSS BAR
65
6A
3RP-BK-18
(P-8S)
1
3RP-BK-18
READING LIGHT SWITCH
1
2
3R-WH/BK-18
(P-8S)
3
3R-WH/RD-18
7LPWR-VL-14
READING LIGHT RELAY
7RPWR-BK-14
1
2
3
4
5
6
7
8
9
A
B
36-WH-18
LH READING LAMP
7L-PP-14
45
7LP-VL-14
RH READING LAMP
7R-BK/WH-14
33
7RP-BK-14

NOTES:

1 OPTION P3.1.13.1, CONNECT CIRCUIT 3RP TO 6A CIRCUIT BREAKER AT #22 24V BATTERY BUSS BAR.

PART NO.	DESCRIPTION	REV.
7L-13-2715	ENGINE INSTALLATION CUMMINS	B

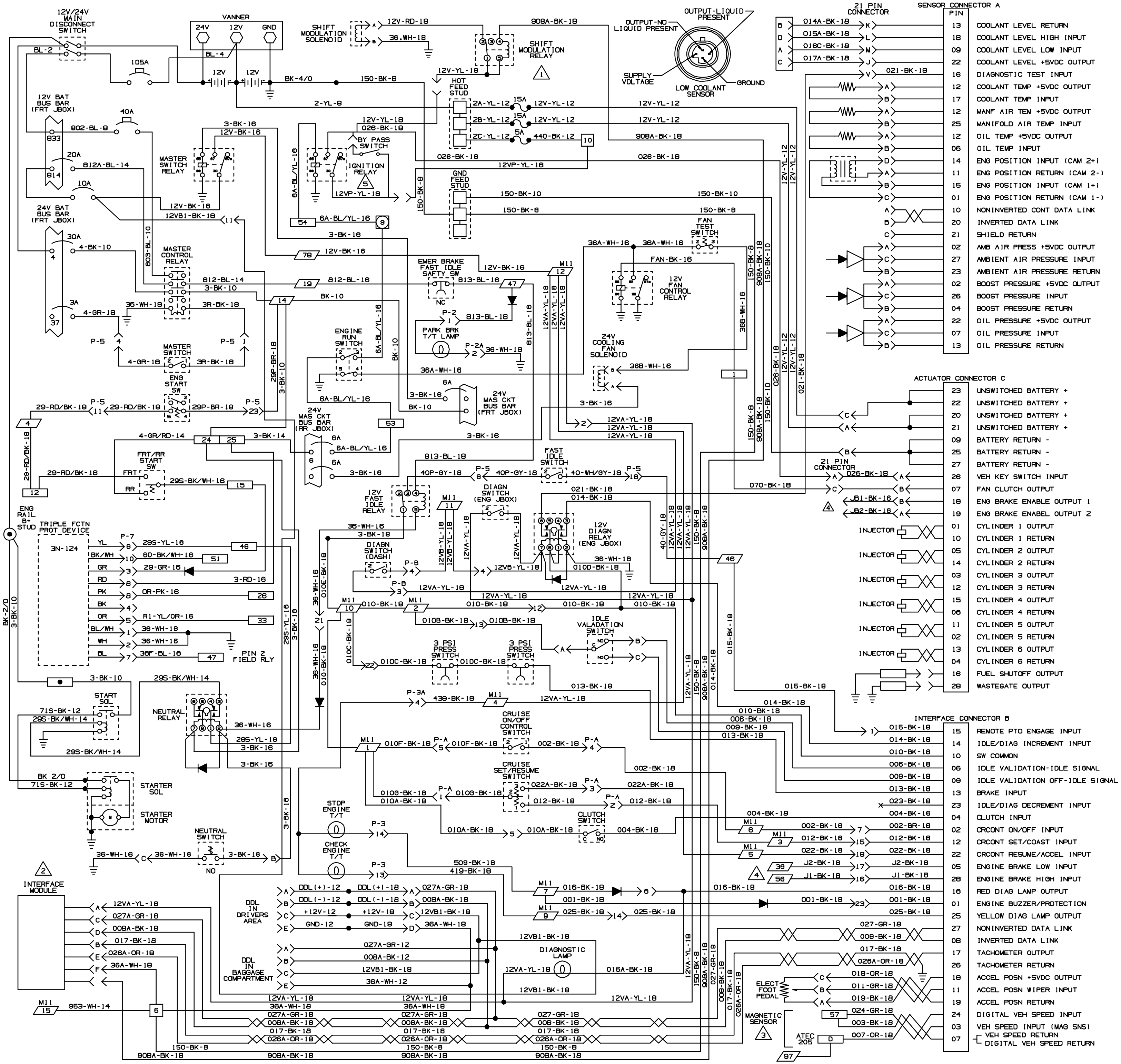
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
◘	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

CUMMINS INSTALLATION W/DIAGNOSTIC SWITCH
102D3 & 102DL3
7L–13–2715 (REV B)


12V/24V MAIN DISCONNECT SWITCH
BL-2
BL-4
VANNER
24V
12V
GND
105A
BK-4/0
150-BK-8
2-YL-8
12V BAT BUS BAR (FRT JBOX)
40A
802-BL-8
833
20A
814
812A-BL-14
10A
24V BAT BUS BAR (FRT JBOX)
30A
4-BK-10
3A
4-GR-18
37
MASTER SWITCH RELAY
12V-BK-16
12VB1-BK-18
MASTER CONTROL RELAY
803-BL-10
812-BL-14
3-BK-10
3R-BK-18
36-WH-18
MASTER SWITCH
ENG START SW
P-5
29-RD/BK-18
29P-BR-18
SHIFT MODULATION SOLENOID
12V-RD-18
36-WH-18
908A-BK-18
SHIFT MODULATION RELAY
12V-YL-18
HOT FEED STUD
2A-YL-12
2B-YL-12
2C-YL-12
15A
5A
12V-YL-12
440-BK-12
IGNITION RELAY
BY PASS SWITCH
12VP-YL-18
026-BK-18
GND FEED STUD
150-BK-10
150-BK-8
OUTPUT-LIQUID PRESENT
OUTPUT-NO LIQUID PRESENT
SUPPLY VOLTAGE
LOW COOLANT SENSOR
GROUND
EMER BRAKE FAST IDLE SAFTY SW
NC
813-BL-16
PARK BRK T/T LAMP
FAN TEST SWITCH
FAN-BK-16
36A-WH-16
12V FAN CONTROL RELAY
24V COOLING FAN SOLENOID
36B-WH-16
ENGINE RUN SWITCH
6A-BL/YL-16
24V MAS CKT BUS BAR (FRT JBOX)
24V MAS CKT BUS BAR (RR JBOX)
FRT/RR START SW
FRT
RR
29S-BK/WH-16
4-GR/RD-14
12V FAST IDLE RELAY
FAST IDLE SWITCH
40P-GY-18
40-WH/GY-18
DIAGN SWITCH (ENG JBOX)
12V DIAGN RELAY (ENG JBOX)
DIAGN SWITCH (DASH)
ENG RAIL B+ STUD
TRIPLE FCTN PROT DEVICE
3N-124
YL
BK/WH
GR
RD
PK
BK
OR
BL/WH
WH
BL
P-7
29S-YL-16
60-BK/WH-16
29-GR-16
3-RD-16
OR-PK-16
R1-YL/OR-16
36F-BL-16
PIN 2 FIELD RLY
BK-2/0
3-BK-10
START SOL
71S-BK-12
29S-BK/WH-14
NEUTRAL RELAY
STARTER SOL
STARTER MOTOR
BK 2/0
NEUTRAL SWITCH
NO
36-WH-16
IDLE VALADATION SWITCH
3 PSI PRESS SWITCH
010C-BK-18
013-BK-18
439-BK-18
12VA-YL-18
CRUISE ON/OFF CONTROL SWITCH
CRUISE SET/RESUME SWITCH
CLUTCH SWITCH
STOP ENGINE T/T
CHECK ENGINE T/T
P-3
509-BK-18
419-BK-18
DDL IN DRIVERS AREA
DDL IN BAGGAGE COMPARTMENT
DDL(+)-12
DDL(-)-12
+12V-12
GND-12
027A-GR-18
008A-BK-18
12VB1-BK-18
36A-WH-18
DIAGNOSTIC LAMP
016A-BK-18
INTERFACE MODULE
017-BK-18
026A-OR-18
953-WH-14
M11
21 PIN CONNECTOR
SENSOR CONNECTOR A
PIN
13 COOLANT LEVEL RETURN
18 COOLANT LEVEL HIGH INPUT
09 COOLANT LEVEL LOW INPUT
22 COOLANT LEVEL +5VDC OUTPUT
16 DIAGNOSTIC TEST INPUT
12 COOLANT TEMP +5VDC OUTPUT
17 COOLANT TEMP INPUT
12 MANF AIR TEM +5VDC OUTPUT
25 MANIFOLD AIR TEMP INPUT
12 OIL TEMP +5VDC OUTPUT
06 OIL TEMP INPUT
14 ENG POSITION INPUT (CAM 2+)
11 ENG POSITION RETURN (CAM 2-)
15 ENG POSITION INPUT (CAM 1+)
01 ENG POSITION RETURN (CAM 1-)
10 NONINVERTED CONT DATA LINK
20 INVERTED DATA LINK
21 SHIELD RETURN
02 AMB AIR PRESS +5VDC OUTPUT
27 AMBIENT AIR PRESSURE INPUT
23 AMBIENT AIR PRESSURE RETURN
02 BOOST PRESSURE +5VDC OUTPUT
26 BOOST PRESSURE INPUT
04 BOOST PRESSURE RETURN
22 OIL PRESSURE +5VDC OUTPUT
07 OIL PRESSURE INPUT
13 OIL PRESSURE RETURN
ACTUATOR CONNECTOR C
23 UNSWITCHED BATTERY +
22 UNSWITCHED BATTERY +
20 UNSWITCHED BATTERY +
21 UNSWITCHED BATTERY +
09 BATTERY RETURN -
25 BATTERY RETURN -
27 BATTERY RETURN -
26 VEH KEY SWITCH INPUT
07 FAN CLUTCH OUTPUT
18 ENG BRAKE ENABLE OUTPUT 1
19 ENG BRAKE ENABEL OUTPUT 2
01 CYLINDER 1 OUTPUT
10 CYLINDER 1 RETURN
05 CYLINDER 2 OUTPUT
14 CYLINDER 2 RETURN
03 CYLINDER 3 OUTPUT
12 CYLINDER 3 RETURN
15 CYLINDER 4 OUTPUT
06 CYLINDER 4 RETURN
11 CYLINDER 5 OUTPUT
02 CYLINDER 5 RETURN
13 CYLINDER 6 OUTPUT
04 CYLINDER 6 RETURN
16 FUEL SHUTOFF OUTPUT
28 WASTEGATE OUTPUT
INJECTOR
INTERFACE CONNECTOR B
15 REMOTE PTO ENGAGE INPUT
14 IDLE/DIAG INCREMENT INPUT
10 SW COMMON
06 IDLE VALIDATION-IDLE SIGNAL
09 IDLE VALIDATION OFF-IDLE SIGNAL
13 BRAKE INPUT
23 IDLE/DIAG DECREMENT INPUT
04 CLUTCH INPUT
02 CRCONT ON/OFF INPUT
12 CRCONT SET/COAST INPUT
22 CRCONT RESUME/ACCEL INPUT
05 ENGINE BRAKE LOW INPUT
28 ENGINE BRAKE HIGH INPUT
16 RED DIAG LAMP OUTPUT
01 ENGINE BUZZER/PROTECTION
25 YELLOW DIAG LAMP OUTPUT
27 NONINVERTED DATA LINK
08 INVERTED DATA LINK
17 TACHOMETER OUTPUT
26 TACHOMETER RETURN
18 ACCEL POSN +5VDC OUTPUT
11 ACCEL POSN WIPER INPUT
19 ACCEL POSN RETURN
24 DIGITAL VEH SPEED INPUT
03 VEH SPEED INPUT (MAG SNS)
07 VEH SPEED RETURN
DIGITAL VEH SPEED RETURN
ELECT FOOT PEDAL
MAGNETIC SENSOR
ATEC 205
018-OR-18
011-GR-18
019-BK-18
024-GR-18
003-BK-18
007-OR-18

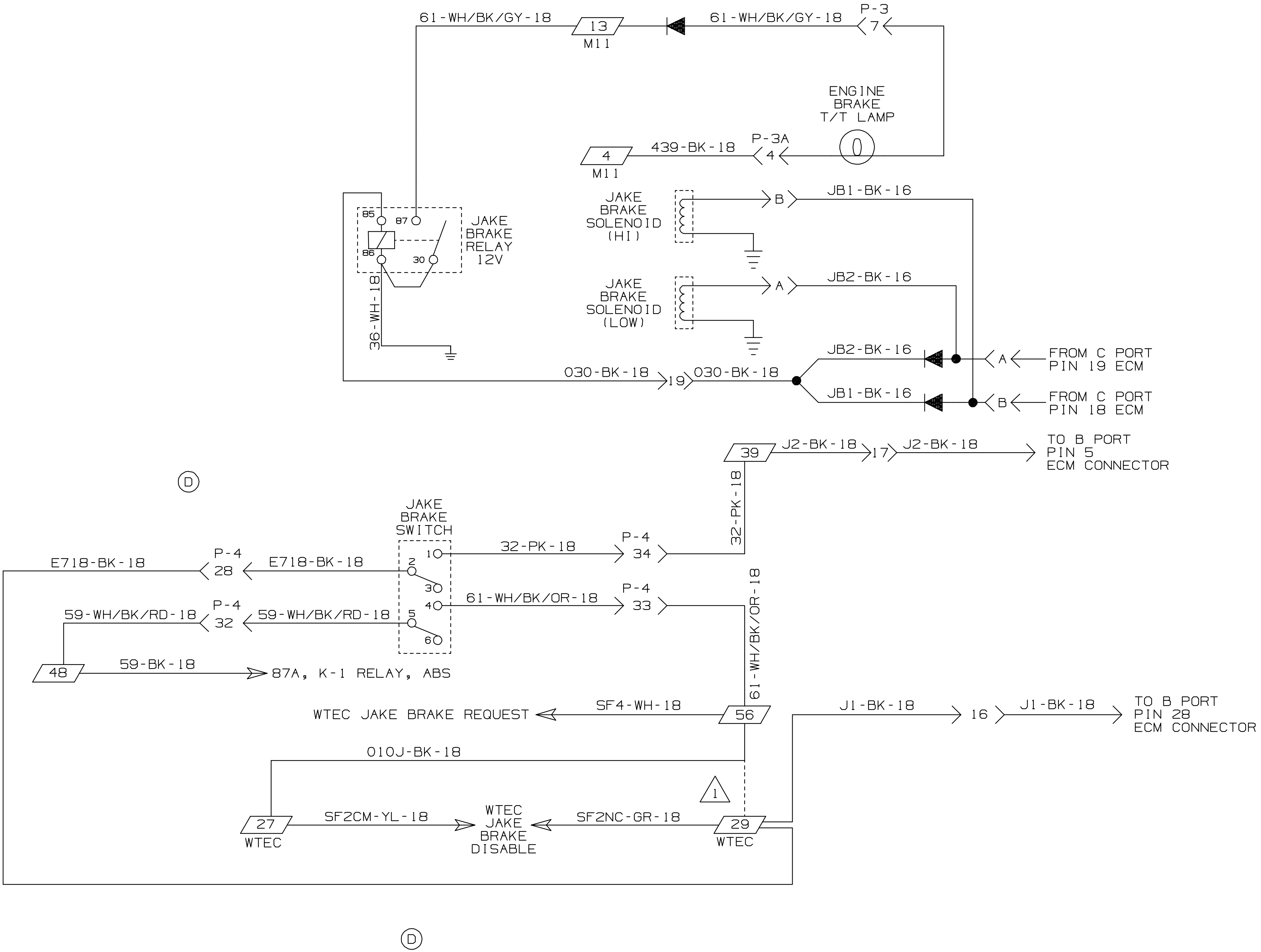
PART NO.	DESCRIPTION	REV.
7L-13-2716	JACOBS ENGINE BRAKE (CUMMINS)	D

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

JACOBS ENGINE BRAKE (CUMMINS)
102D3 & 102DL3
7L–13–2716 (REV D)


61-WH/BK/GY-18
13
M11
61-WH/BK/GY-18
P-3
7
ENGINE
BRAKE
T/T LAMP
4
M11
439-BK-18
P-3A
4
JAKE
BRAKE
RELAY
12V
85
87
86
30
36-WH-18
JAKE
BRAKE
SOLENOID
(HI)
B
JB1-BK-16
JAKE
BRAKE
SOLENOID
(LOW)
A
JB2-BK-16
JB2-BK-16
A
FROM C PORT
PIN 19 ECM
030-BK-18
19
030-BK-18
JB1-BK-16
B
FROM C PORT
PIN 18 ECM
39
J2-BK-18
17
J2-BK-18
TO B PORT
PIN 5
ECM CONNECTOR
32-PK-18
D
JAKE
BRAKE
SWITCH
1
32-PK-18
P-4
34
E718-BK-18
P-4
28
E718-BK-18
2
3
4
61-WH/BK/OR-18
P-4
33
61-WH/BK/OR-18
59-WH/BK/RD-18
P-4
32
59-WH/BK/RD-18
5
6
48
59-BK-18
87A, K-1 RELAY, ABS
WTEC JAKE BRAKE REQUEST
SF4-WH-18
56
J1-BK-18
16
J1-BK-18
TO B PORT
PIN 28
ECM CONNECTOR
010J-BK-18
1
27
WTEC
SF2CM-YL-18
WTEC
JAKE
BRAKE
DISABLE
SF2NC-GR-18
29
WTEC
D

PART NO.	DESCRIPTION	REV.
7L-13-3041	TRACTION CONTROL	B

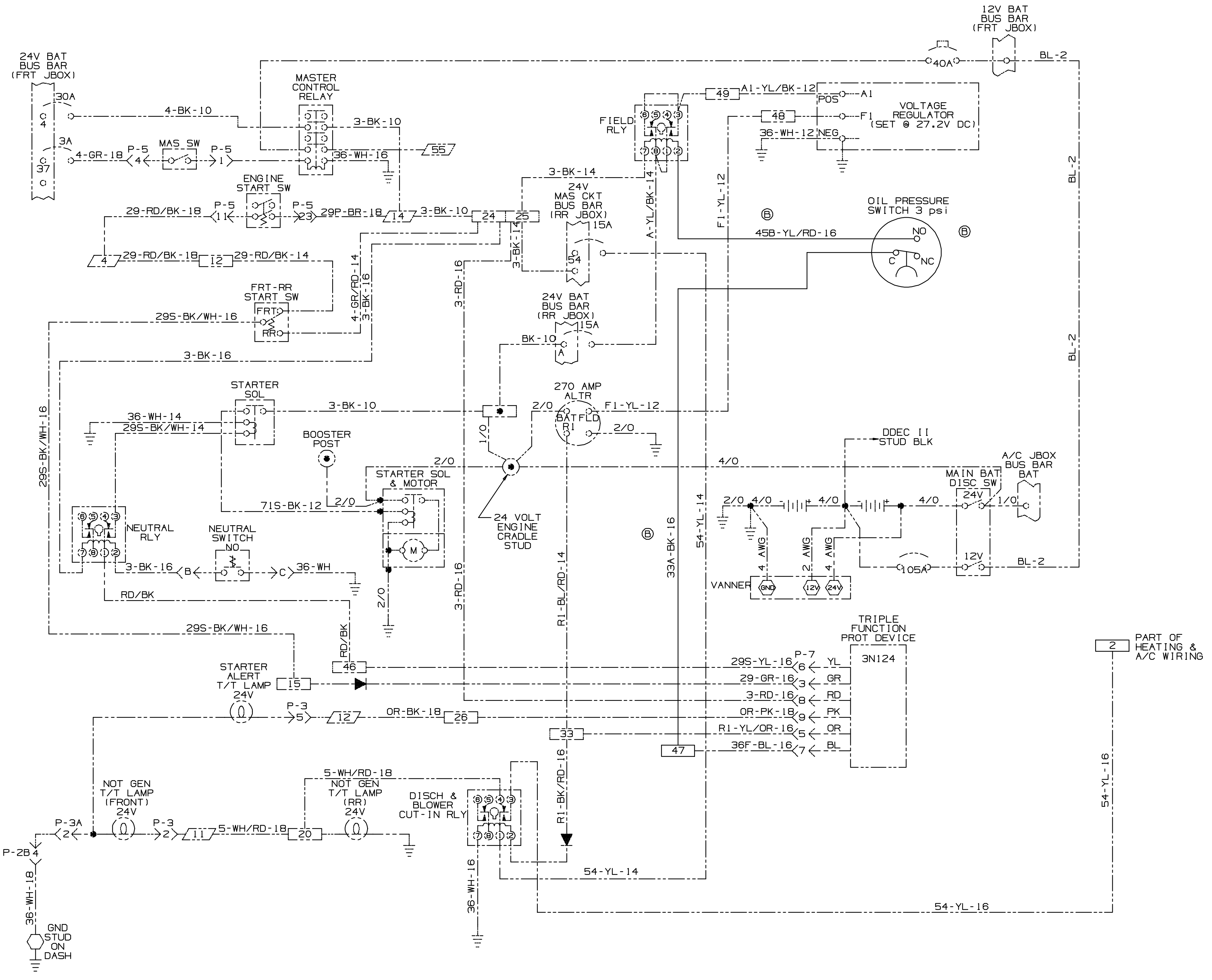
▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J—BOX HORIZ STUD BLK
◇	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE
GR—GREEN

RD—RED
BR—BROWN
BK—BLACK
YL—YELLOW
OR—ORANGE

LEGEND

TRACTION CONTROL
102D3 & 102DL3
7L—13—3041 (REV B)

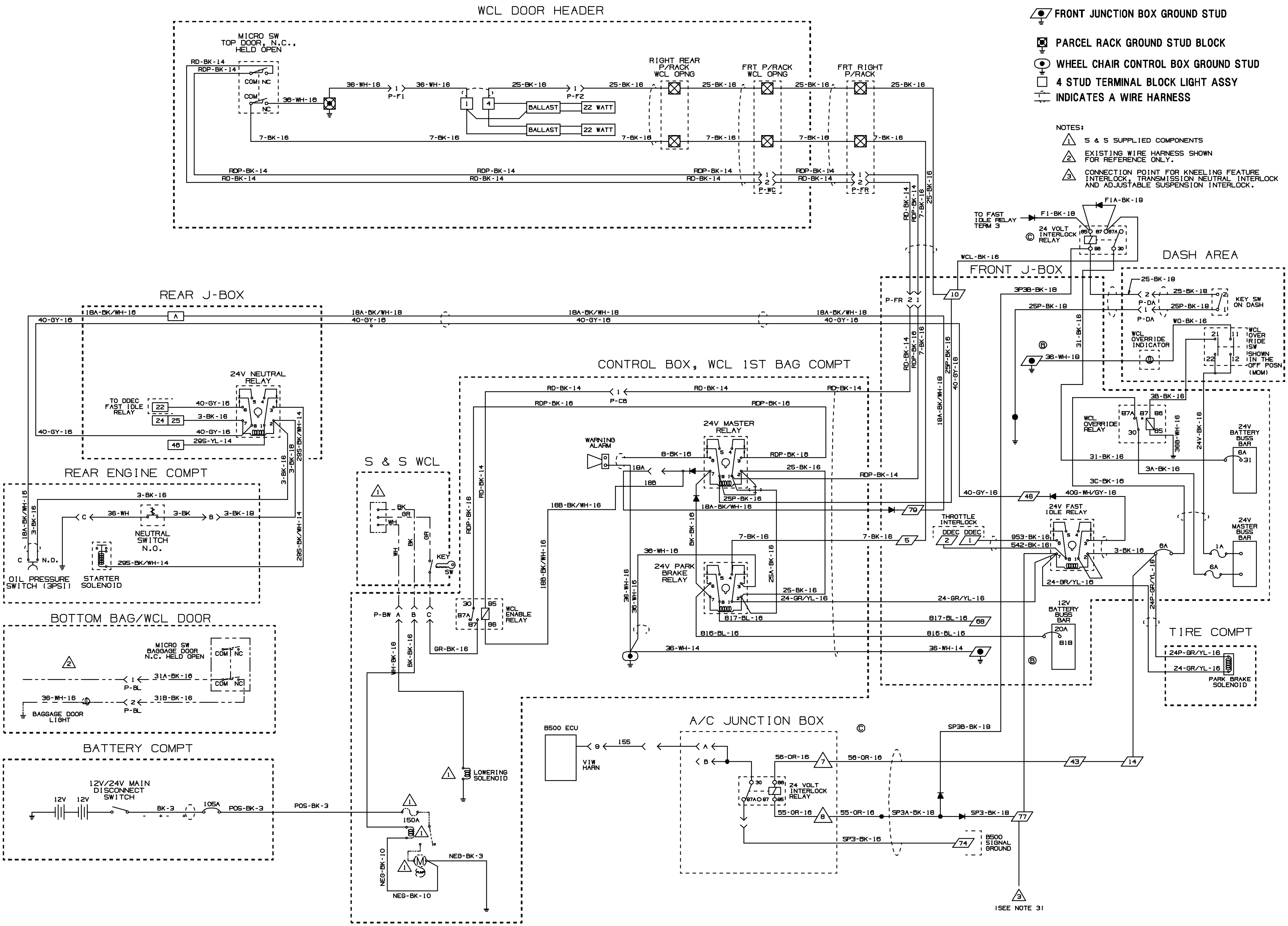

12V BAT
BUS BAR
(FRT JBOX)
40A
BL-2
24V BAT
BUS BAR
(FRT JBOX)
30A
4
3A
37
4-BK-10
4-GR-18
P-5
4
MAS SW
P-5
1
MASTER
CONTROL
RELAY
3-BK-10
36-WH-16
55
ENGINE
START SW
29-RD/BK-18
P-5
11
P-5
23
29P-BR-18
14
3-BK-10
24
25
3-BK-14
4
29-RD/BK-18
12
29-RD/BK-14
FRT-RR
START SW
FRT
RR
29S-BK/WH-16
4-GR/RD-14
3-BK-16
3-BK-16
3-BK-14
3-RD-16
24V
MAS CKT
BUS BAR
(RR JBOX)
15A
54
FIELD
RLY
49
A1-YL/BK-12
POS
A1
48
F1
VOLTAGE
REGULATOR
(SET @ 27.2V DC)
36-WH-12
NEG
A-YL/BK-14
F1-YL-12
BL-2
45B-YL/RD-16
OIL PRESSURE
SWITCH 3 psi
NO
C
NC
Ⓑ
24V BAT
BUS BAR
(RR JBOX)
BK-10
A
15A
BL-2
STARTER
SOL
3-BK-10
36-WH-14
29S-BK/WH-14
29S-BK/WH-16
270 AMP
ALTR
2/0
BAT
FLD
R1
F1-YL-12
2/0
1/0
BOOSTER
POST
2/0
STARTER SOL
& MOTOR
M
4/0
DDEC II
STUD BLK
A/C JBOX
BUS BAR
BAT
MAIN BAT
DISC SW
24V
1/0
NEUTRAL
RLY
NEUTRAL
SWITCH
NO
71S-BK-12
2/0
24 VOLT
ENGINE
CRADLE
STUD
2/0
4/0
4/0
4/0
4 AWG
2 AWG
4 AWG
105A
12V
BL-2
3-BK-16
B
C
36-WH
RD/BK
2/0
3-RD-16
R1-BL/RD-14
33A-BK-16
54-YL-14
VANNER
GND
12V
24V
RD/BK
29S-BK/WH-16
TRIPLE
FUNCTION
PROT DEVICE
3N124
46
29S-YL-16
P-7
6
YL
STARTER
ALERT
T/T LAMP
24V
15
29-GR-16
3
GR
3-RD-16
8
RD
P-3
5
12
OR-BK-18
26
OR-PK-18
9
PK
33
R1-YL/OR-16
5
OR
47
36F-BL-16
7
BL
2
PART OF
HEATING &
A/C WIRING
5-WH/RD-18
NOT GEN
T/T LAMP
(FRONT)
24V
NOT GEN
T/T LAMP
(RR)
24V
DISCH &
BLOWER
CUT-IN RLY
P-3A
2
P-3
2
11
5-WH/RD-18
20
R1-BK/RD-16
P-2B
4
36-WH-18
36-WH-16
54-YL-14
54-YL-16
54-YL-16
GND
STUD
ON
DASH

PART NO.	DESCRIPTION	REV.
7L-13-3060	**S&S WHEELCHAIR LIFT**	**C**

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J–BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J–BOX STUD	⏚	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▣	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◈	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN
YL–YELLOW
OR–ORANGE
RD–RED
BR–BROWN
BK–BLACK

LEGEND



WCL DOOR HEADER
MICRO SW TOP DOOR, N.C., HELD OPEN
RD-BK-14
RDP-BK-14
COM
NC
36-WH-16
36-WH-16
P-F1
25-BK-16
P-F2
BALLAST
22 WATT
7-BK-16
RIGHT REAR P/RACK WCL OPNG
FRT P/RACK WCL OPNG
FRT RIGHT P/RACK
P-WC
P-FR
REAR J-BOX
18A-BK/WH-16
40-GY-16
24V NEUTRAL RELAY
TO DDEC FAST IDLE RELAY
22
24
25
48
3-BK-16
29S-YL-14
29S-BK/WH-14
REAR ENGINE COMPT
36-WH
3-BK
3-BK-18
NEUTRAL SWITCH N.O.
OIL PRESSURE SWITCH (3PSI)
STARTER SOLENOID
29S-BK/WH-14
BOTTOM BAG/WCL DOOR
MICRO SW BAGGAGE DOOR N.C. HELD OPEN
31A-BK-16
31B-BK-16
P-BL
36-WH-16
BAGGAGE DOOR LIGHT
BATTERY COMPT
12V/24V MAIN DISCONNECT SWITCH
12V
12V
BK-3
105A
POS-BK-3
S & S WCL
BK
GR
WH
KEY SW
P-BW
WH-BK-16
BX-BK-16
GR-BK-16
LOWERING SOLENOID
150A
NEG-BK-10
NEG-BK-3
CONTROL BOX, WCL 1ST BAG COMPT
RD-BK-14
RDP-BK-16
P-CB
WCL ENABLE RELAY
18B-BK/WH-16
WARNING ALARM
8-BK-16
18A
18B
24V MASTER RELAY
25P-BK-16
18A-BK/WH-16
8K-BK-16
7-BK-16
25A-BK-16
24V PARK BRAKE RELAY
36-WH-16
25-BK-16
24-GR/YL-16
817-BL-16
816-BL-16
36-WH-14
FRONT J-BOX
10
79
5
68
46
40-GY-16
40G-WH/GY-16
24V FAST IDLE RELAY
THROTTLE INTERLOCK
DDEC 2
DDEC 1
953-BK-16
542-BK-16
24-GR/YL-16
12V BATTERY BUSS BAR
20A
818
TO FAST IDLE RELAY TERM 3
F1-BK-18
F1A-BK-18
24 VOLT INTERLOCK RELAY
WCL-BK-16
SP3B-BK-18
25P-BK-18
DASH AREA
25-BK-18
P-DA
KEY SW ON DASH
WCL OVERRIDE INDICATOR
W0-BK-16
WCL OVER RIDE SW SHOWN IN THE OFF POSN (MOM)
36-WH-18
31-BK-16
36-BK-16
WCL OVERRIDE RELAY
36B-WH-16
24V-BK-16
24V BATTERY BUSS BAR
6A
3C-BK-16
3A-BK-16
24V MASTER BUSS BAR
1A
3-BK-16
24P-GR/YL-16
TIRE COMPT
PARK BRAKE SOLENOID
B500 ECU
155
VIW HARN
A/C JUNCTION BOX
56-OR-16
24 VOLT INTERLOCK RELAY
55-OR-16
SP3A-BK-18
SP3-BK-18
SP3-BK-16
43
14
77
74
B500 SIGNAL GROUND
(SEE NOTE 3)

FRONT JUNCTION BOX GROUND STUD

PARCEL RACK GROUND STUD BLOCK

WHEEL CHAIR CONTROL BOX GROUND STUD

4 STUD TERMINAL BLOCK LIGHT ASSY

INDICATES A WIRE HARNESS

NOTES:

1. S & S SUPPLIED COMPONENTS
2. EXISTING WIRE HARNESS SHOWN FOR REFERENCE ONLY.
3. CONNECTION POINT FOR KNEELING FEATURE INTERLOCK, TRANSMISSION NEUTRAL INTERLOCK AND ADJUSTABLE SUSPENSION INTERLOCK.

PART NO.	DESCRIPTION	REV.
7L-13-3064	INTERIOR LIGHTING	B

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
◘	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

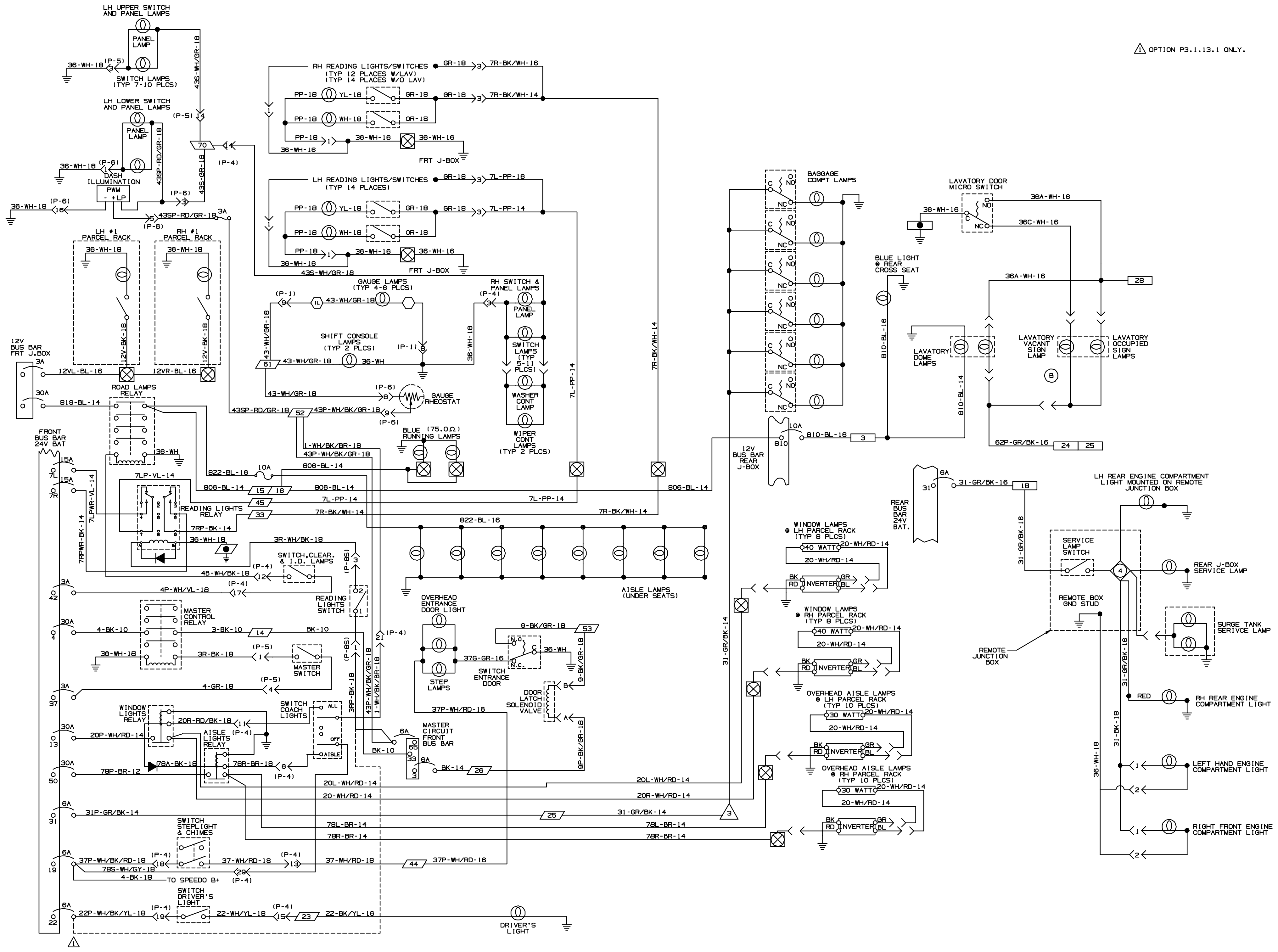
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

INTERIOR LIGHTING
102D3 & 102DL3
7L–13–3064 (REV B)

⚠ OPTION P3.1.13.1 ONLY.



LH UPPER SWITCH AND PANEL LAMPS
PANEL LAMP
SWITCH LAMPS (TYP 7-10 PLCS)
LH LOWER SWITCH AND PANEL LAMPS
DASH ILLUMINATION
PWM
LH #1 PARCEL RACK
RH #1 PARCEL RACK
12V BUS BAR FRT J.BOX
ROAD LAMPS RELAY
FRONT BUS BAR 24V BAT
READING LIGHTS RELAY
SWITCH, CLEAR. & I.D. LAMPS
READING LIGHTS SWITCH
MASTER CONTROL RELAY
MASTER SWITCH
WINDOW LIGHTS RELAY
AISLE LIGHTS RELAY
SWITCH COACH LIGHTS
ALL
OFF
AISLE
MASTER CIRCUIT FRONT BUS BAR
SWITCH STEPLIGHT & CHIMES
SWITCH DRIVER'S LIGHT
DRIVER'S LIGHT
TO SPEEDO B+
RH READING LIGHTS/SWITCHES (TYP 12 PLACES W/LAV) (TYP 14 PLACES W/O LAV)
LH READING LIGHTS/SWITCHES (TYP 14 PLACES)
FRT J-BOX
GAUGE LAMPS (TYP 4-6 PLCS)
SHIFT CONSOLE LAMPS (TYP 2 PLCS)
GAUGE RHEOSTAT
RH SWITCH & PANEL LAMPS
SWITCH LAMPS (TYP 5-11 PLCS)
WASHER CONT LAMP
WIPER CONT LAMPS (TYP 2 PLCS)
BLUE (75.0Ω) RUNNING LAMPS
AISLE LAMPS (UNDER SEATS)
OVERHEAD ENTRANCE DOOR LIGHT
STEP LAMPS
SWITCH ENTRANCE DOOR
DOOR LATCH SOLENOID VALVE
BAGGAGE COMPT LAMPS
12V BUS BAR REAR J-BOX
REAR BUS BAR 24V BAT.
LAVATORY DOOR MICRO SWITCH
BLUE LIGHT @ REAR CROSS SEAT
LAVATORY DOME LAMPS
LAVATORY VACANT SIGN LAMP
LAVATORY OCCUPIED SIGN LAMPS
WINDOW LAMPS @ LH PARCEL RACK (TYP 8 PLCS)
WINDOW LAMPS @ RH PARCEL RACK (TYP 8 PLCS)
OVERHEAD AISLE LAMPS @ LH PARCEL RACK (TYP 10 PLCS)
OVERHEAD AISLE LAMPS @ RH PARCEL RACK (TYP 10 PLCS)
40 WATT
30 WATT
INVERTER
LH REAR ENGINE COMPARTMENT LIGHT MOUNTED ON REMOTE JUNCTION BOX
SERVICE LAMP SWITCH
REMOTE BOX GND STUD
REMOTE JUNCTION BOX
REAR J-BOX SERVICE LAMP
SURGE TANK SERIVCE LAMP
RH REAR ENGINE COMPARTMENT LIGHT
LEFT HAND ENGINE COMPARTMENT LIGHT
RIGHT FRONT ENGINE COMPARTMENT LIGHT
36-WH-18
43S-WH/GR-18
43SP-RD/GR-18
12VL-BL-16
12VR-BL-16
819-BL-14
822-BL-16
806-BL-14
7LP-VL-14
7L-PP-14
7R-BK/WH-14
7RP-BK-14
3R-WH/BK-18
4B-WH/BK-18
4P-WH/VL-18
4-BK-10
3-BK-10
3R-BK-18
4-GR-18
20R-RD/BK-18
20P-WH/RD-14
78P-BR-12
78A-BK-18
78R-BR-18
20L-WH/RD-14
20-WH/RD-14
20R-WH/RD-14
31P-GR/BK-14
31-GR/BK-14
78L-BR-14
78R-BR-14
37P-WH/BK/RD-18
78S-WH/GY-18
4-BK-18
37-WH/RD-18
37P-WH/RD-16
22P-WH/BK/YL-18
22-WH/YL-18
22-BK/YL-16
43-WH/GR-18
43P-WH/BK/GR-18
1-WH/BK/BR-18
9-BK/GR-18
37G-GR-16
9P-BK/GR-18
810-BL-16
810-BL-14
36A-WH-16
36C-WH-16
62P-GR/BK-16
31-GR/BK-16
31-BK-18
36-WH-16
7R-BK/WH-16
7L-PP-16

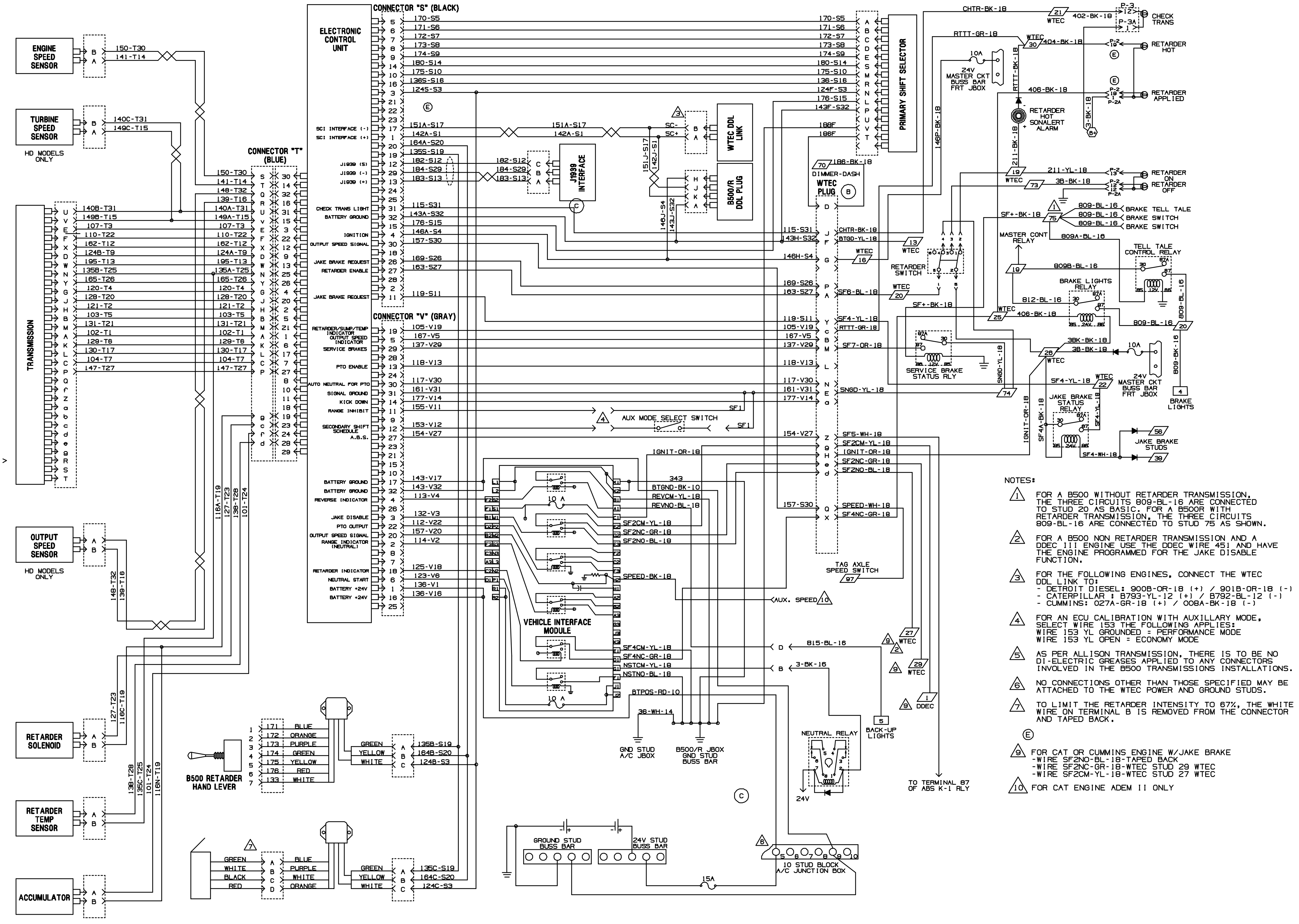
PART NO.	DESCRIPTION	REV.
7L-13-3112	TRANSMISSION CONTROL B500 & B500R (WTEC, 24V)	E

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

WTEC INSTALLATION – 24V SYSTEM (B500 & B5500F
102D3 & 102DL3
7L–13–3112 (REV E)


ENGINE SPEED SENSOR
TURBINE SPEED SENSOR
HD MODELS ONLY
TRANSMISSION
OUTPUT SPEED SENSOR
HD MODELS ONLY
RETARDER SOLENOID
RETARDER TEMP SENSOR
ACCUMULATOR
B500 RETARDER HAND LEVER
CONNECTOR "T" (BLUE)
ELECTRONIC CONTROL UNIT
CONNECTOR "S" (BLACK)
CONNECTOR "V" (GRAY)
SCI INTERFACE (-)
SCI INTERFACE (+)
J1939 (S)
J1939 (-)
J1939 (+)
CHECK TRANS LIGHT
BATTERY GROUND
IGNITION
OUTPUT SPEED SIGNAL
JAKE BRAKE REQUEST
RETARDER ENABLE
JAKE BRAKE REQUEST
RETARDER/SUMP/TEMP INDICATOR
OUTPUT SPEED INDICATOR
SERVICE BRAKES
PTO ENABLE
AUTO NEUTRAL FOR PTO
SIGNAL GROUND
KICK DOWN
RANGE INHIBIT
SECONDARY SHIFT SCHEDULE
A.B.S.
BATTERY GROUND
BATTERY GROUND
REVERSE INDICATOR
JAKE DISABLE
PTO OUTPUT
OUTPUT SPEED SIGNAL
RANGE INDICATOR (NEUTRAL)
RETARDER INDICATOR
NEUTRAL START
BATTERY +24V
BATTERY +24V
J1939 INTERFACE
WTEC DDL LINK
B500/R DDL PLUG
PRIMARY SHIFT SELECTOR
WTEC PLUG
DIMMER-DASH
AUX MODE SELECT SWITCH
VEHICLE INTERFACE MODULE
AUX. SPEED
TAG AXLE SPEED SWITCH
CHECK TRANS
RETARDER HOT
RETARDER APPLIED
RETARDER HOT SONALERT ALARM
RETARDER ON
RETARDER OFF
24V MASTER CKT BUSS BAR FRT JBOX
BRAKE TELL TALE
BRAKE SWITCH
BRAKE SWITCH
MASTER CONT RELAY
TELL TALE CONTROL RELAY
RETARDER SWITCH
BRAKE LIGHTS RELAY
SERVICE BRAKE STATUS RLY
24V MASTER CKT BUSS BAR FRT JBOX
BRAKE LIGHTS
JAKE BRAKE STATUS RELAY
JAKE BRAKE STUDS
BACK-UP LIGHTS
NEUTRAL RELAY
TO TERMINAL 87 OF ABS K-1 RLY
GND STUD A/C JBOX
B500/R JBOX GND STUD BUSS BAR
GROUND STUD BUSS BAR
24V STUD BUSS BAR
10 STUD BLOCK A/C JUNCTION BOX
15A
10A
24V

NOTES:

1. FOR A B500 WITHOUT RETARDER TRANSMISSION, THE THREE CIRCUITS 809-BL-16 ARE CONNECTED TO STUD 20 AS BASIC. FOR A B500R WITH RETARDER TRANSMISSION, THE THREE CIRCUITS 809-BL-16 ARE CONNECTED TO STUD 75 AS SHOWN.

2. FOR A B500 NON RETARDER TRANSMISSION AND A DDEC III ENGINE USE THE DDEC WIRE 451 AND HAVE THE ENGINE PROGRAMMED FOR THE JAKE DISABLE FUNCTION.

3. FOR THE FOLLOWING ENGINES, CONNECT THE WTEC DDL LINK TO:
- DETROIT DIESEL: 900B-OR-18 (+) / 901B-OR-18 (-)
- CATERPILLAR : B793-YL-12 (+) / B792-BL-12 (-)
- CUMMINS: 027A-GR-18 (+) / 008A-BK-18 (-)

4. FOR AN ECU CALIBRATION WITH AUXILLARY MODE, SELECT WIRE 153 THE FOLLOWING APPLIES:
WIRE 153 YL GROUNDED = PERFORMANCE MODE
WIRE 153 YL OPEN = ECONOMY MODE

5. AS PER ALLISON TRANSMISSION, THERE IS TO BE NO DI-ELECTRIC GREASES APPLIED TO ANY CONNECTORS INVOLVED IN THE B500 TRANSMISSIONS INSTALLATIONS.

6. NO CONNECTIONS OTHER THAN THOSE SPECIFIED MAY BE ATTACHED TO THE WTEC POWER AND GROUND STUDS.

7. TO LIMIT THE RETARDER INTENSITY TO 67%, THE WHITE WIRE ON TERMINAL B IS REMOVED FROM THE CONNECTOR AND TAPED BACK.

Ⓔ

9. FOR CAT OR CUMMINS ENGINE W/JAKE BRAKE
-WIRE SF2NO-BL-18-TAPED BACK
-WIRE SF2NC-GR-18-WTEC STUD 29 WTEC
-WIRE SF2CM-YL-18-WTEC STUD 27 WTEC

10. FOR CAT ENGINE ADEM II ONLY

PART NO.	DESCRIPTION	REV.
7L-13-3146	TARGET CLUSTER (LH)	A

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

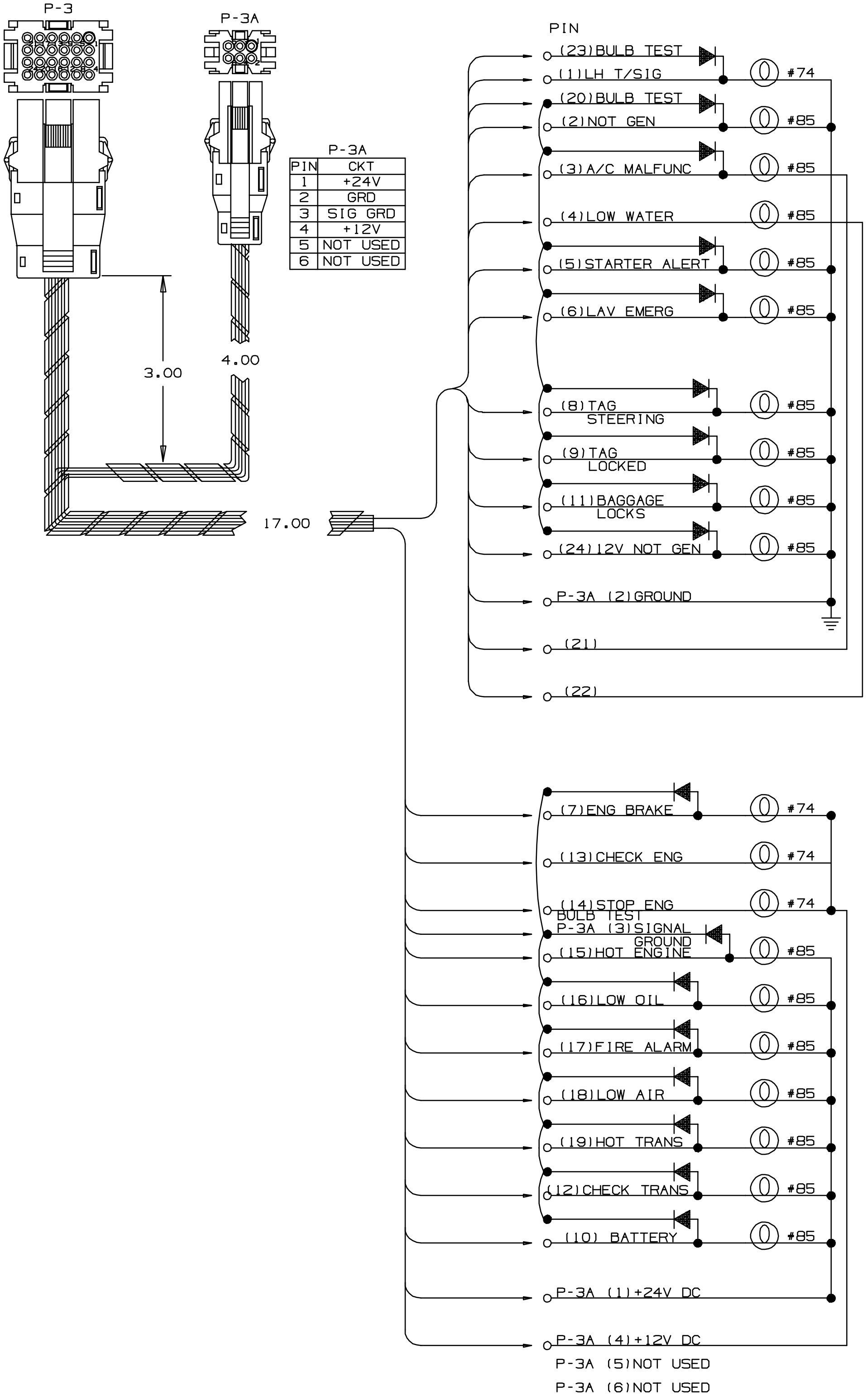
WH–WHITE	RD–RED
GY–GREY	BR–BROWN
VO–VIOLET	BK–BLACK
BL–BLUE	YL–YELLOW
GR–GREEN	OR–ORANGE

LEGEND

LH TARGET CLUSTER W/TEST CIRCUI
102D3 & 102DL3
7L–13–3146 (REV A)

P-3

PIN	CKT
1	LH T/SIG
2	NOT GEN
3	A/C MALFUNC
4	LOW WATER
5	START ALERT
6	LAV EMER
7	ENG BRAKE
8	TAG STEERING
9	TAG LOCKED
10	BATTERY
11	BAG LOCKS
12	CHECK TRANS
13	CHECK ENG
14	STOP ENG BULB TEST
15	HOT ENG
16	LOW OIL
17	FIRE ALARM
18	LOW AIR
19	HOT TRANS
20	BULB TEST
21	A/C MALFUNC
22	LOW WATER
23	BULB TEST
24	12 V NOT GEN


P-3
P-3A
3.00
4.00
17.00
PIN
(23)BULB TEST
(1)LH T/SIG
#74
(20)BULB TEST
(2)NOT GEN
#85
(3)A/C MALFUNC
#85
(4)LOW WATER
#85
(5)STARTER ALERT
#85
(6)LAV EMERG
#85
(8)TAG STEERING
#85
(9)TAG LOCKED
#85
(11)BAGGAGE LOCKS
#85
(24)12V NOT GEN
#85
P-3A (2)GROUND
(21)
(22)
(7)ENG BRAKE
#74
(13)CHECK ENG
#74
(14)STOP ENG BULB TEST
#74
P-3A (3)SIGNAL GROUND
(15)HOT ENGINE
#85
(16)LOW OIL
#85
(17)FIRE ALARM
#85
(18)LOW AIR
#85
(19)HOT TRANS
#85
(12)CHECK TRANS
#85
(10) BATTERY
#85
P-3A (1)+24V DC
P-3A (4)+12V DC
P-3A (5)NOT USED
P-3A (6)NOT USED

P-3A

PIN	CKT
1	+24V
2	GRD
3	SIG GRD
4	+12V
5	NOT USED
6	NOT USED

PART NO.	DESCRIPTION	REV.
7L-13-3219	JACOBS ENGINE BRAKE (CATERPILLAR)	C

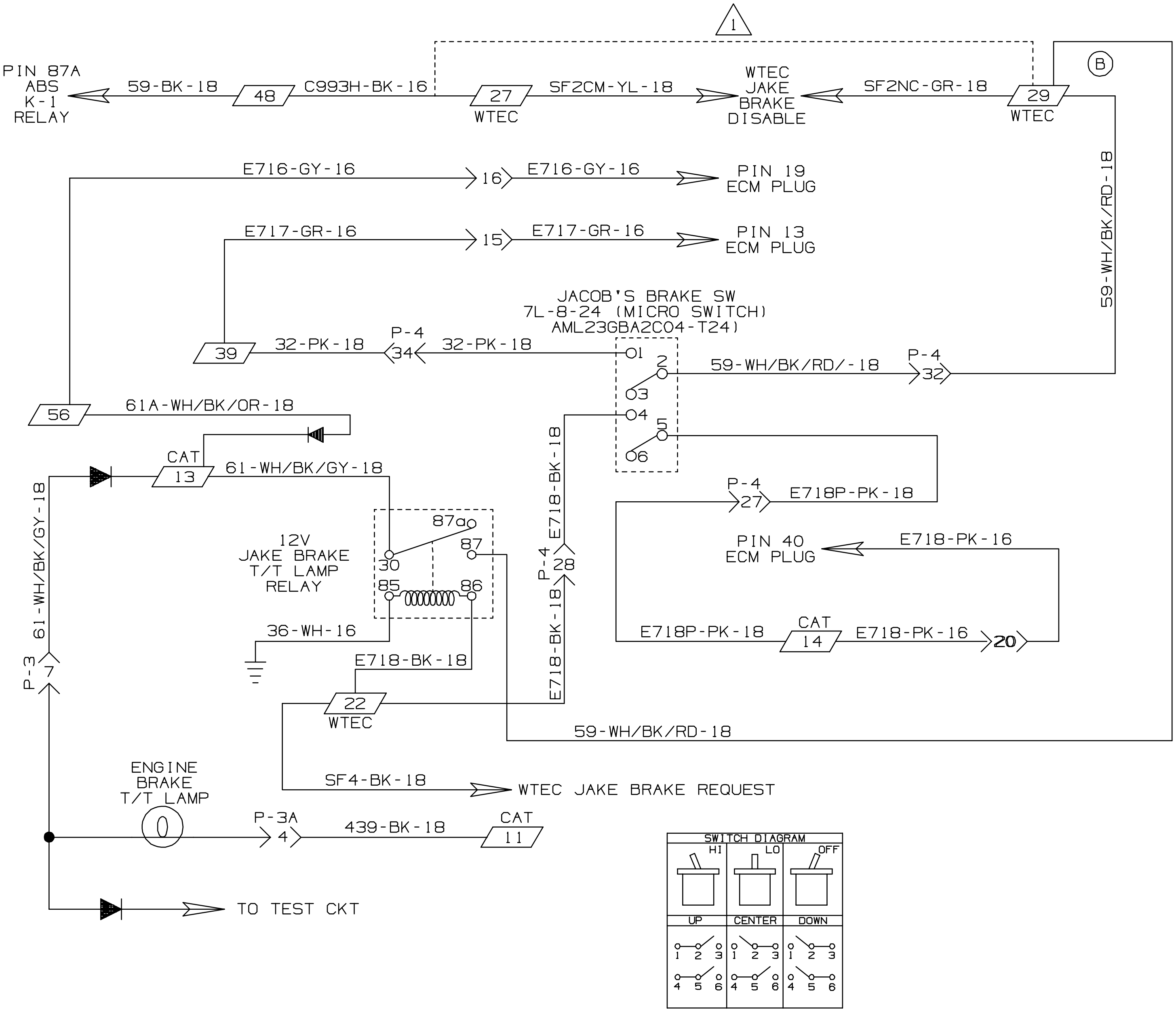
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
IL	BEHIND DASH ILLUM STUD
B+	BEHIND DASH B+ STUD
⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

JACOBS ENGINE BRAKE (CATERPILLAR)
102D3 & 102DL3
7L—13—3219 (REV C)


1
B
PIN 87A ABS K-1 RELAY
59-BK-18
48
C993H-BK-16
27
WTEC
SF2CM-YL-18
WTEC JAKE BRAKE DISABLE
SF2NC-GR-18
29
WTEC
59-WH/BK/RD-18
E716-GY-16
16
E716-GY-16
PIN 19 ECM PLUG
E717-GR-16
15
E717-GR-16
PIN 13 ECM PLUG
JACOB'S BRAKE SW
7L-8-24 (MICRO SWITCH)
AML23GBA2C04-T24)
39
32-PK-18
P-4
34
32-PK-18
1
2
3
4
5
6
59-WH/BK/RD/-18
P-4
32
56
61A-WH/BK/OR-18
CAT
13
61-WH/BK/GY-18
61-WH/BK/GY-18
E718-BK-18
P-4
28
E718-BK-18
P-4
27
E718P-PK-18
12V JAKE BRAKE T/T LAMP RELAY
87a
87
30
85
86
PIN 40 ECM PLUG
E718-PK-16
36-WH-16
E718-BK-18
E718P-PK-18
CAT
14
E718-PK-16
20
P-3
7
22
WTEC
59-WH/BK/RD-18
SF4-BK-18
WTEC JAKE BRAKE REQUEST
ENGINE BRAKE T/T LAMP
P-3A
4
439-BK-18
CAT
11
TO TEST CKT
SWITCH DIAGRAM
HI
LO
OFF
UP
CENTER
DOWN
1 2 3
4 5 6
1 2 3
4 5 6
1 2 3
4 5 6

NOTES:

1 FOR COACHES WITHOUT B500 TRANSMISSIONS, CONNECT C993H JUMPER TO WTEC STUD 29.

Ⓒ

PART NO.	DESCRIPTION	REV.
7L-13-3226	BAGGAGE DOOR TELL-TALE	B

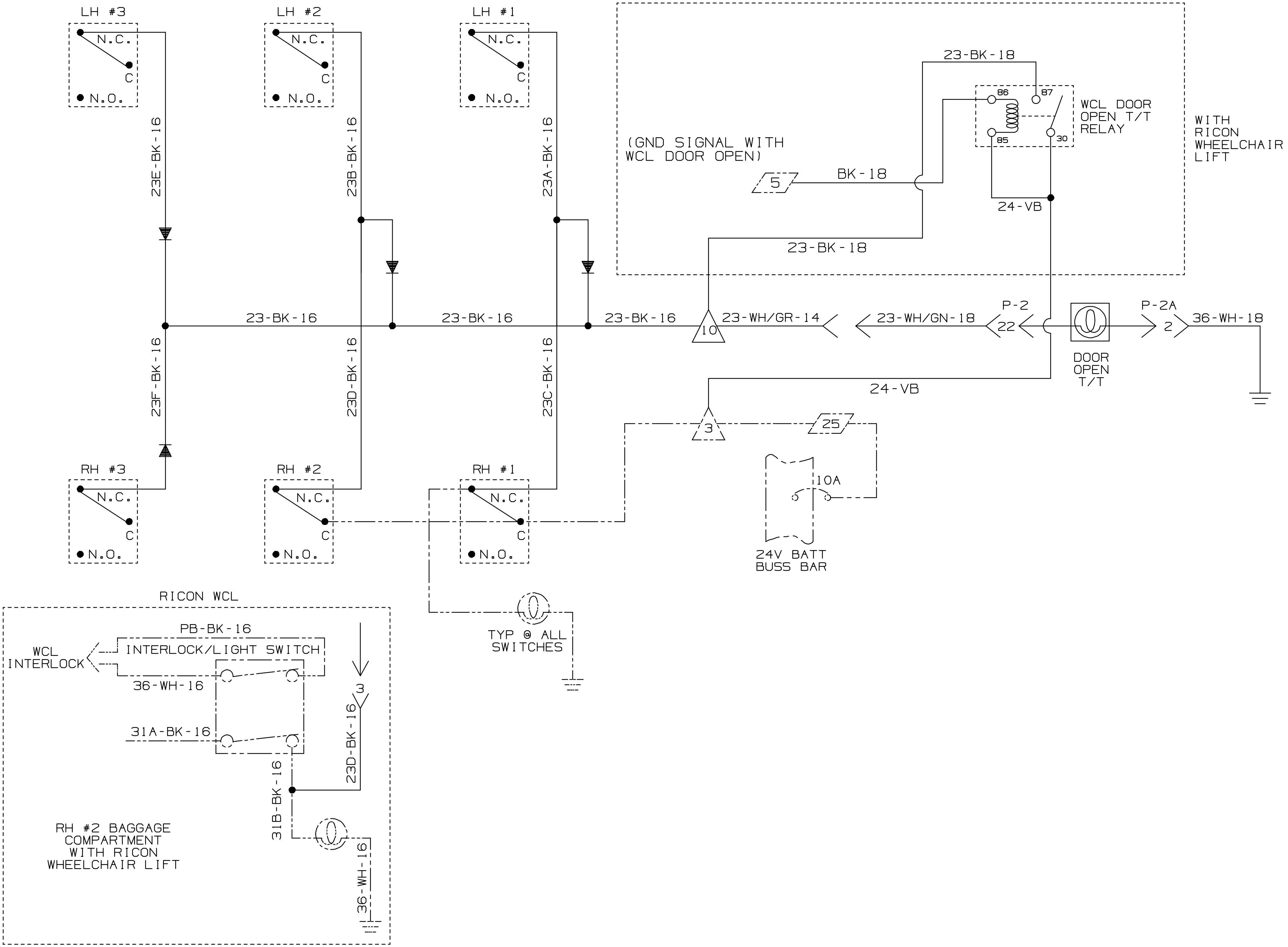
▱	FRT J—BOX STUD BLOCK
▱	FRONT J—BOX STUD
▱○	FRT J—BOX ENT STUD BLK
▭	REAR J—BOX STUD BLOCK
▭	REAR J—BOX STUD
△	A/C J—BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
⧇	REM CONT J—BOX HORIZ STUD BLK
◈	REM CONT J—BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE
GR—GREEN

RD—RED
BR—BROWN
BK—BLACK
YL—YELLOW
OR—ORANGE

LEGEND

BAGGAGE DOOR TELL—TALE
102D3 & 102DL3
7L—13—3226 (REV B)


LH #3
LH #2
LH #1
N.C.
C
N.O.
23E-BK-16
23B-BK-16
23A-BK-16
23F-BK-16
23D-BK-16
23C-BK-16
23-BK-16
23-BK-18
WCL DOOR OPEN T/T RELAY
86
87
85
30
WITH RICON WHEELCHAIR LIFT
(GND SIGNAL WITH WCL DOOR OPEN)
5
BK-18
24-VB
10
23-WH/GR-14
23-WH/GN-18
P-2
22
DOOR OPEN T/T
P-2A
2
36-WH-18
3
25
10A
24V BATT BUSS BAR
RH #3
RH #2
RH #1
TYP @ ALL SWITCHES
RICON WCL
PB-BK-16
INTERLOCK/LIGHT SWITCH
WCL INTERLOCK
36-WH-16
31A-BK-16
31B-BK-16
23D-BK-16
3
36-WH-16
RH #2 BAGGAGE COMPARTMENT WITH RICON WHEELCHAIR LIFT

PART NO.	DESCRIPTION	REV.
7L-13-3274	BRAKE & TRANSMISSION NEUTRAL INTERLOCK	E

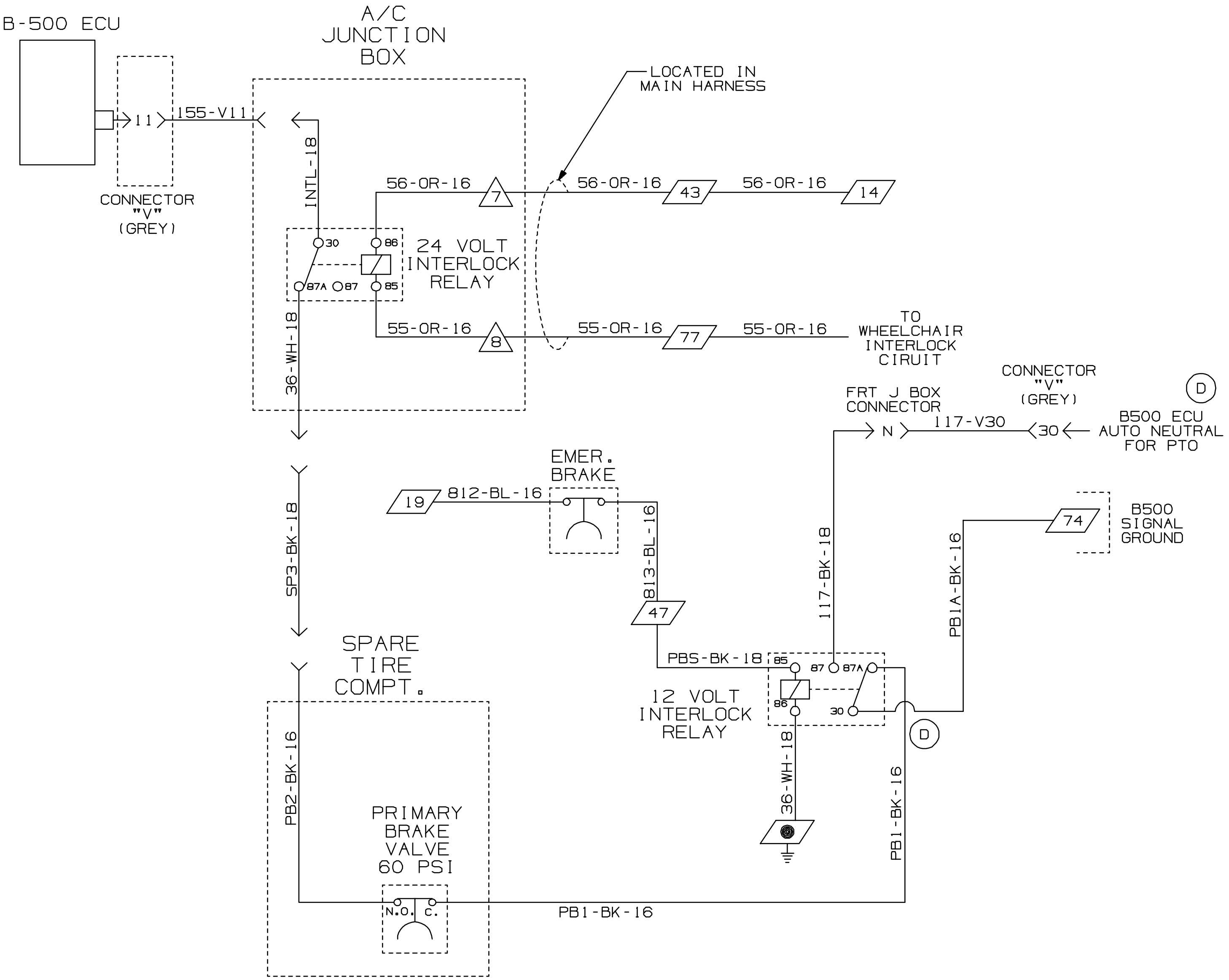
▱	FRT J—BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J—BOX STUD	○	ENGINE CRADLE STUD
▱	FRT J—BOX ENT STUD BLK	IL	BEHIND DASH ILLUM STUD
▭	REAR J—BOX STUD BLOCK	B+	BEHIND DASH B+ STUD
▭	REAR J—BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J—BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J—BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J—BOX VERT STUD BLK	— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE

GR—GREEN
YL—YELLOW
OR—ORANGE

RD—RED
BR—BROWN
BK—BLACK

LEGEND


B-500 ECU
CONNECTOR "V" (GREY)
11
155-V11
A/C JUNCTION BOX
INTL-18
56-OR-16
7
LOCATED IN MAIN HARNESS
56-OR-16
43
56-OR-16
14
30
86
24 VOLT INTERLOCK RELAY
87A
87
85
55-OR-16
8
55-OR-16
77
55-OR-16
TO WHEELCHAIR INTERLOCK CIRUIT
36-WH-18
CONNECTOR "V" (GREY)
D
FRT J BOX CONNECTOR
N
117-V30
30
B500 ECU AUTO NEUTRAL FOR PTO
EMER. BRAKE
19
812-BL-16
SP3-BK-18
813-BL-16
47
117-BK-18
74
B500 SIGNAL GROUND
PB1A-BK-16
SPARE TIRE COMPT.
PBS-BK-18
85
87
87A
12 VOLT INTERLOCK RELAY
86
30
D
36-WH-18
PB2-BK-16
PB1-BK-16
PRIMARY BRAKE VALVE 60 PSI
N.O.
C.
PB1-BK-16

PART NO.	DESCRIPTION	REV.
7L-13-3323	ESPAR HEATER	A

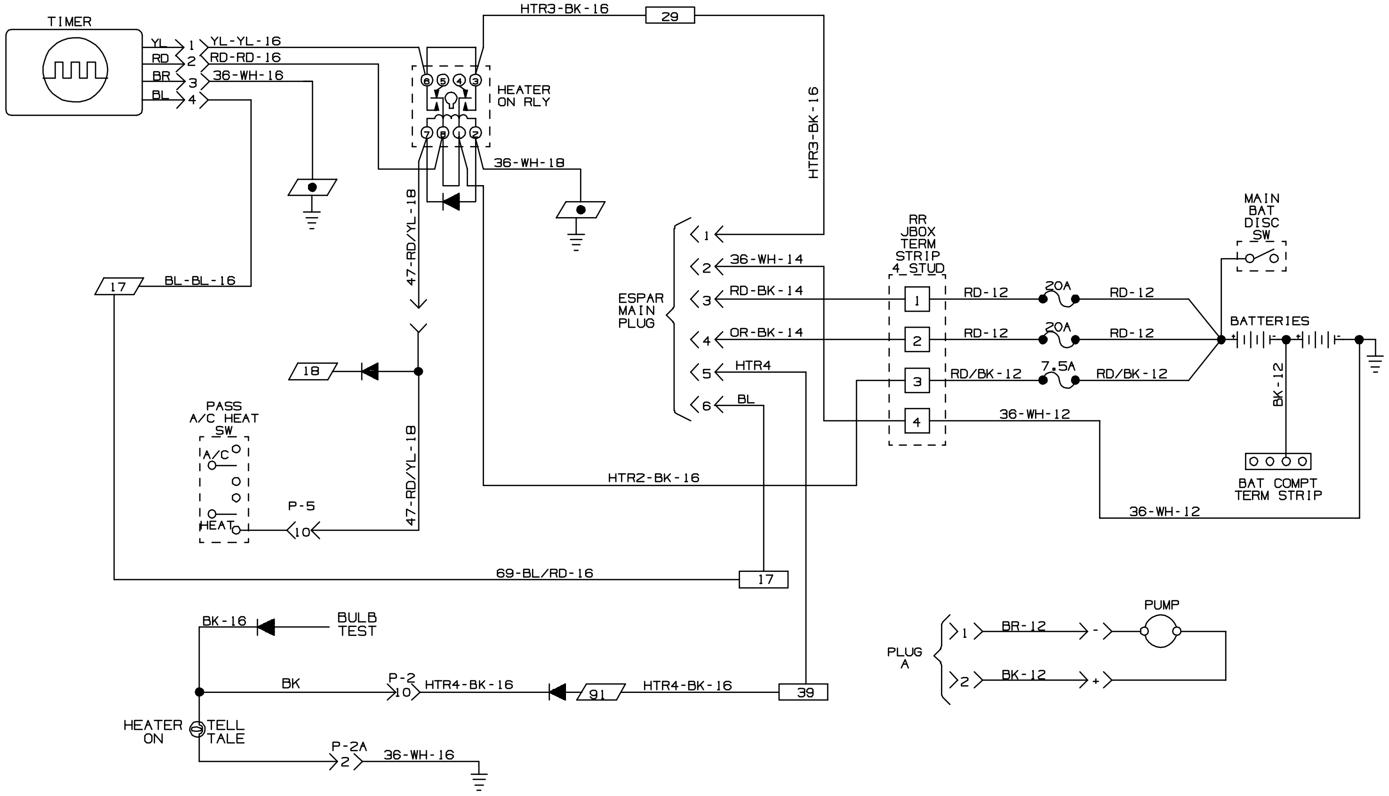
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
⧇	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
⍓	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

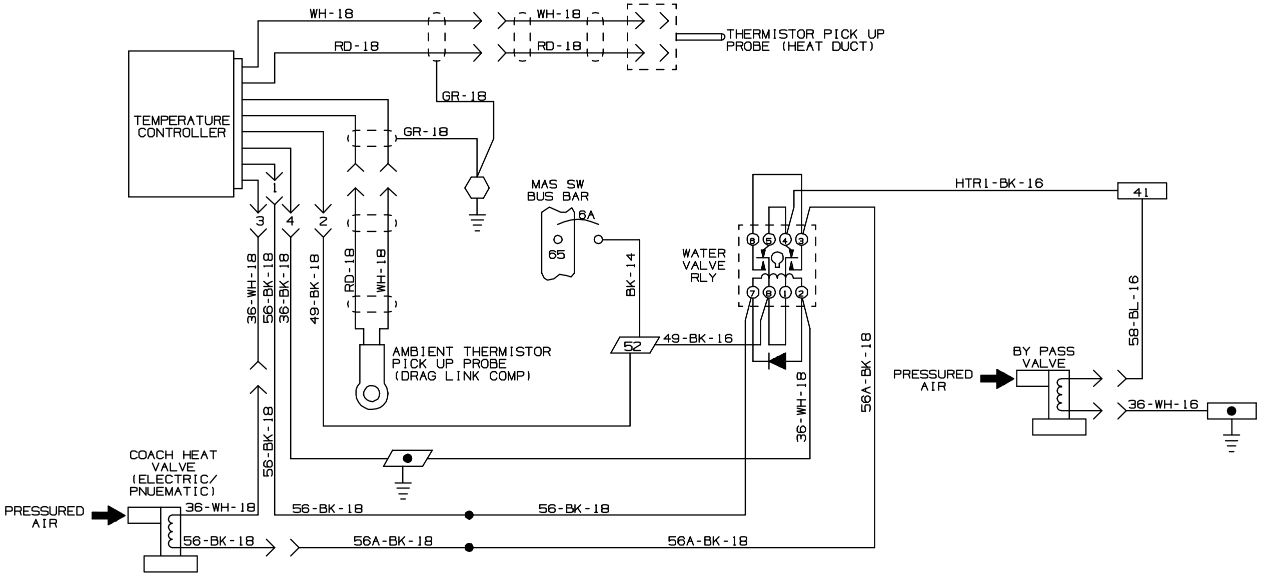
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

ESPAR HEATER
102D3 & 102DL3
7L–13–3323 (REV A)


TIMER
YL
RD
BR
BL
1
2
3
4
YL-YL-16
RD-RD-16
36-WH-16
HTR3-BK-16
29
HEATER ON RLY
36-WH-18
HTR3-BK-16
47-RD/YL-18
BL-BL-16
17
18
PASS A/C HEAT SW
A/C
HEAT
P-5
10
47-RD/YL-18
ESPAR MAIN PLUG
1
2
3
4
5
6
36-WH-14
RD-BK-14
OR-BK-14
HTR4
BL
RR JBOX TERM STRIP 4 STUD
RD-12
20A
RD-12
RD-12
20A
RD-12
RD/BK-12
7.5A
RD/BK-12
36-WH-12
MAIN BAT DISC SW
BATTERIES
BK-12
BAT COMPT TERM STRIP
HTR2-BK-16
36-WH-12
69-BL/RD-16
17
BK-16
BULB TEST
BK
P-2
10
HTR4-BK-16
91
HTR4-BK-16
39
HEATER ON
TELL TALE
P-2A
2
36-WH-16
PUMP
PLUG A
BR-12
BK-12
-
+


WH-18
RD-18
WH-18
RD-18
THERMISTOR PICK UP PROBE (HEAT DUCT)
TEMPERATURE CONTROLLER
GR-18
GR-18
3
1
4
2
36-WH-18
56-BK-18
36-BK-18
49-BK-18
RD-18
WH-18
AMBIENT THERMISTOR PICK UP PROBE (DRAG LINK COMP)
MAS SW BUS BAR
6A
65
BK-14
52
49-BK-16
WATER VALVE RLY
HTR1-BK-16
41
58-BL-16
56A-BK-18
36-WH-18
PRESSURED AIR
BY PASS VALVE
36-WH-16
56-BK-18
COACH HEAT VALVE (ELECTRIC/ PNUEMATIC)
PRESSURED AIR
36-WH-18
56-BK-18
56-BK-18
56-BK-18
56A-BK-18
56A-BK-18

PART NO.	DESCRIPTION	REV.
7L-13-3391	**PARCEL RACK BLOWERS**	

▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
☒	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◇	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡ ⏚	BEHIND DASH GND STUD
◭	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

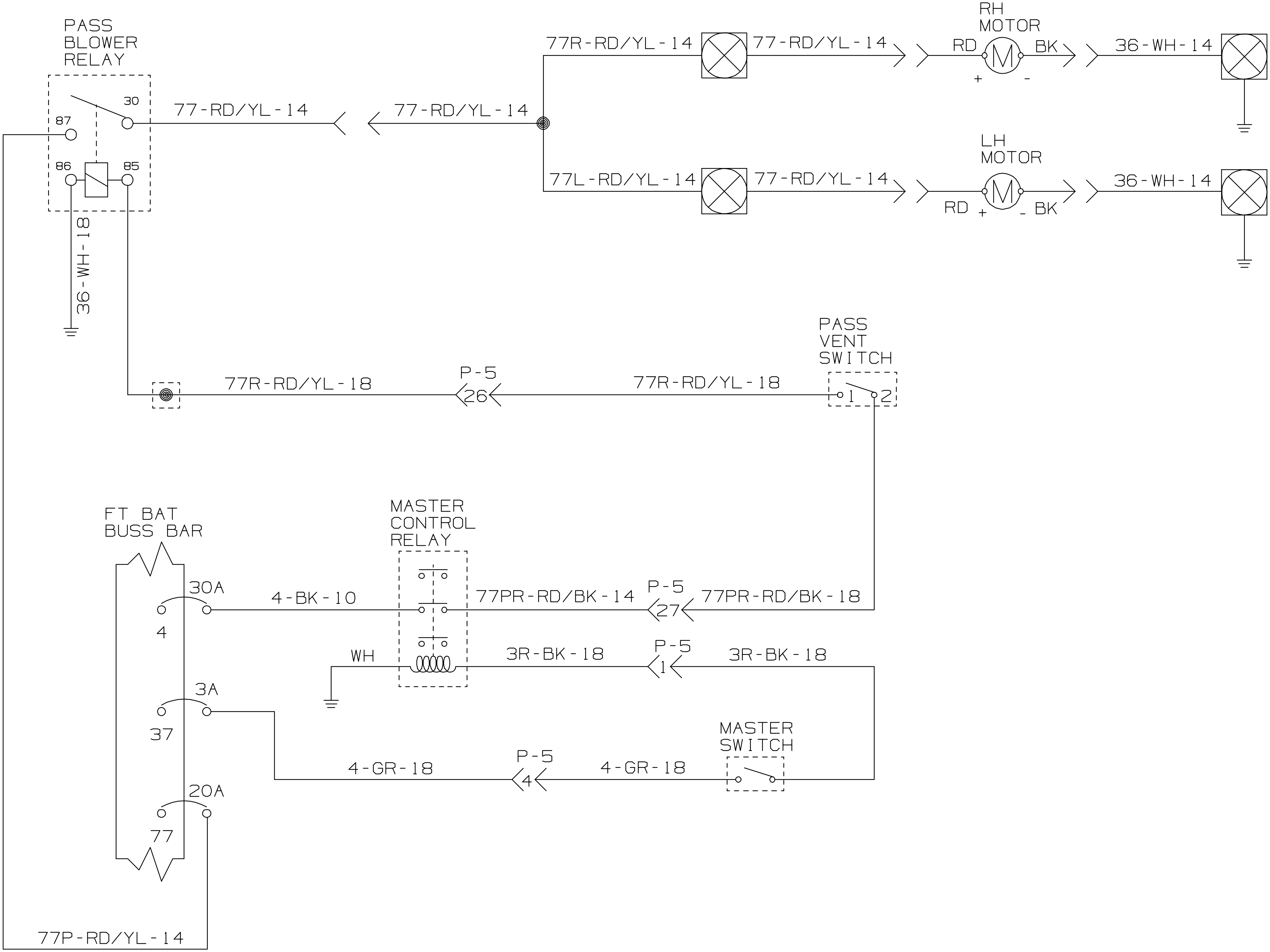
WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

Parcel Rack Blowers Schematic
102D3 & 102DL3 MODELS

7L–13–3391


PASS
BLOWER
RELAY
30
87
86
85
77-RD/YL-14
77-RD/YL-14
77R-RD/YL-14
77-RD/YL-14
RH
MOTOR
RD
BK
+
-
36-WH-14
77L-RD/YL-14
77-RD/YL-14
LH
MOTOR
RD
+
-
BK
36-WH-14
36-WH-18
77R-RD/YL-18
P-5
26
77R-RD/YL-18
PASS
VENT
SWITCH
1
2
FT BAT
BUSS BAR
MASTER
CONTROL
RELAY
30A
4
4-BK-10
77PR-RD/BK-14
P-5
27
77PR-RD/BK-18
WH
3R-BK-18
P-5
1
3R-BK-18
3A
37
MASTER
SWITCH
4-GR-18
P-5
4
4-GR-18
20A
77
77P-RD/YL-14

PART NO.	DESCRIPTION	REV.
7L-13-3393	HEATING & AIR CONDITIONING	B

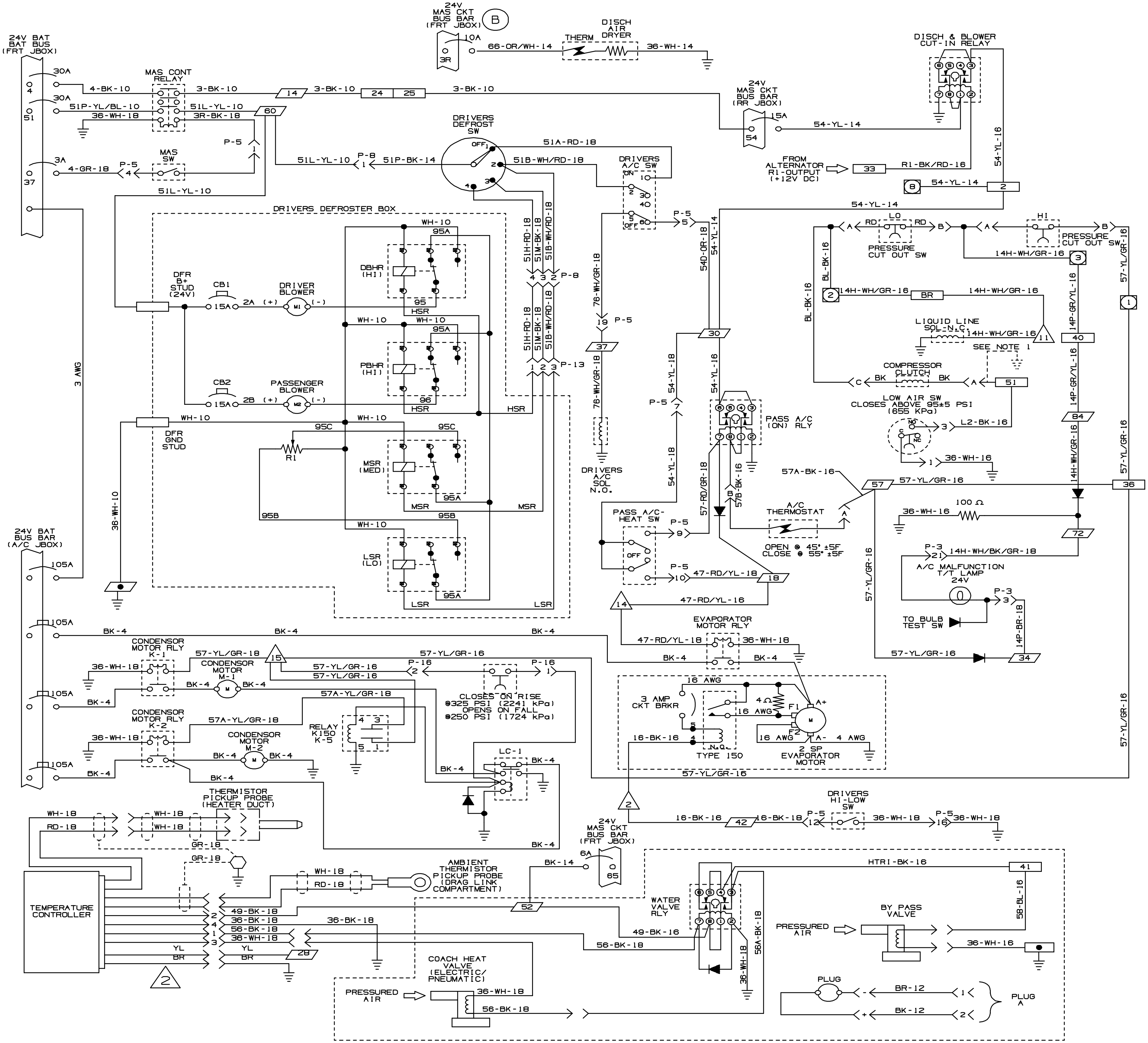
▱	FRT J–BOX STUD BLOCK
▱	FRONT J–BOX STUD
▱○	FRT J–BOX ENT STUD BLK
▭	REAR J–BOX STUD BLOCK
▭	REAR J–BOX STUD
△	A/C J–BOX STUD BLOCK
⊠	PARCEL RACK STUD BLOCK
▢	REM CONT J–BOX HORIZ STUD BLK
◈	REM CONT J–BOX VERT STUD BLK
○	ENG CRADLE STUD BLK
○	ENGINE CRADLE STUD
⬡ IL	BEHIND DASH ILLUM STUD
⬡ B+	BEHIND DASH B+ STUD
⬡	BEHIND DASH GND STUD
⍍	DEST SIGN STUD BLOCK
▽	SENSING ELEMENT PLUG
⊗	ROOF HARNESS BLK STUD
— —	OPTION

WH–WHITE
GY–GREY
VO–VIOLET
BL–BLUE
GR–GREEN

RD–RED
BR–BROWN
BK–BLACK
YL–YELLOW
OR–ORANGE

LEGEND

HEATING AND AIR CONDITIONING
102D3 & 102DL3
7L–13–3393 (REV B)



24V BAT BAT BUS (FRT JBOX)
30A
4
30A
51
3A
37
3 AWG
4-BK-10
51P-YL/BL-10
36-WH-18
MAS CONT RELAY
3-BK-10
51L-YL-10
3R-BK-18
60
14
3-BK-10
24
25
3-BK-10
P-5
MAS SW
4-GR-18
51L-YL-10
24V MAS CKT BUS BAR (FRT JBOX)
B
10A
3R
66-OR/WH-14
THERM
DISCH AIR DRYER
36-WH-14
DISCH & BLOWER CUT-IN RELAY
24V MAS CKT BUS BAR (RR JBOX)
15A
54
54-YL-14
54-YL-16
FROM ALTERNATOR R1-OUTPUT (+12V DC)
33
R1-BK/RD-16
8
54-YL-14
2
54-YL-14
DRIVERS DEFROST SW
OFF
51A-RD-18
51B-WH/RD-18
51P-BK-14
51L-YL-10
P-8
DRIVERS A/C SW
ON
OFF
P-5
DRIVERS DEFROSTER BOX
WH-10
95A
DBHR (HI)
95
HSR
DFR B+ STUD (24V)
CB1
15A
2A
DRIVER BLOWER
M1
WH-10
PBHR (HI)
96
CB2
2B
PASSENGER BLOWER
M2
HSR
95C
MSR (MED)
R1
95B
MSR
LSR (LO)
LSR
DFR GND STUD
36-WH-10
51H-RD-18
51M-BK-18
51B-WH/RD-18
P-13
76-WH/GR-18
37
DRIVERS A/C SOL N.O.
54D-OR-18
54-YL-14
30
54-YL-18
54-YL-16
PASS A/C (ON) RLY
57-RD/GR-18
57B-BK-16
PASS A/C-HEAT SW
47-RD/YL-18
18
47-RD/YL-16
14
A/C THERMOSTAT
OPEN @ 45° ±5F
CLOSE @ 55° ±5F
57A-BK-16
57
57-YL/GR-16
36
LO
RD
PRESSURE CUT OUT SW
H1
PRESSURE CUT OUT SW
14H-WH/GR-16
3
BL-BK-16
14H-WH/GR-16
BR
LIQUID LINE SOL-N.C.
14H-WH/GR-16
11
SEE NOTE 1
COMPRESSOR CLUTCH
BK
51
40
14P-GR/YL-16
LOW AIR SW CLOSES ABOVE 95±5 PSI (655 KPa)
L2-BK-16
36-WH-16
84
14H-WH/GR-16
1
100 Ω
72
P-3
14H-WH/BK/GR-18
A/C MALFUNCTION T/T LAMP 24V
TO BULB TEST SW
14P-BR-18
57-YL/GR-16
34
24V BAT BUS BAR (A/C JBOX)
105A
BK-4
CONDENSOR MOTOR RLY K-1
57-YL/GR-18
15
CONDENSOR MOTOR M-1
57-YL/GR-16
P-16
CLOSES ON RISE @325 PSI (2241 KPa) OPENS ON FALL @250 PSI (1724 KPa)
57A-YL/GR-18
RELAY K150 K-5
CONDENSOR MOTOR RLY K-2
CONDENSOR MOTOR M-2
LC-1
EVAPORATOR MOTOR RLY
47-RD/YL-18
36-WH-18
16 AWG
3 AMP CKT BRKR
4 Ω
F1
F2
A+
A-
4 AWG
16-BK-16
N.O.
TYPE 150
2 SP EVAPORATOR MOTOR
57-YL/GR-16
2
DRIVERS HI-LOW SW
16-BK-16
42
16-BK-18
P-5
36-WH-18
THERMISTOR PICKUP PROBE (HEATER DUCT)
WH-18
RD-18
GR-18
TEMPERATURE CONTROLLER
24V MAS CKT BUS BAR (FRT JBOX)
6A
65
BK-14
AMBIENT THERMISTOR PICKUP PROBE (DRAG LINK COMPARTMENT)
52
49-BK-18
36-BK-18
56-BK-18
36-WH-18
YL
BR
28
WATER VALVE RLY
49-BK-16
56-BK-18
36-WH-18
56A-BK-18
HTR1-BK-16
41
58-BL-16
BY PASS VALVE
PRESSURED AIR
36-WH-16
COACH HEAT VALVE (ELECTRIC/ PNEUMATIC)
PRESSURED AIR
36-WH-18
56-BK-18
PLUG
BR-12
BK-12
PLUG A

PART NO.	DESCRIPTION	REV.
7L-13-3526	RICON WHEELCHAIR LIFT	B

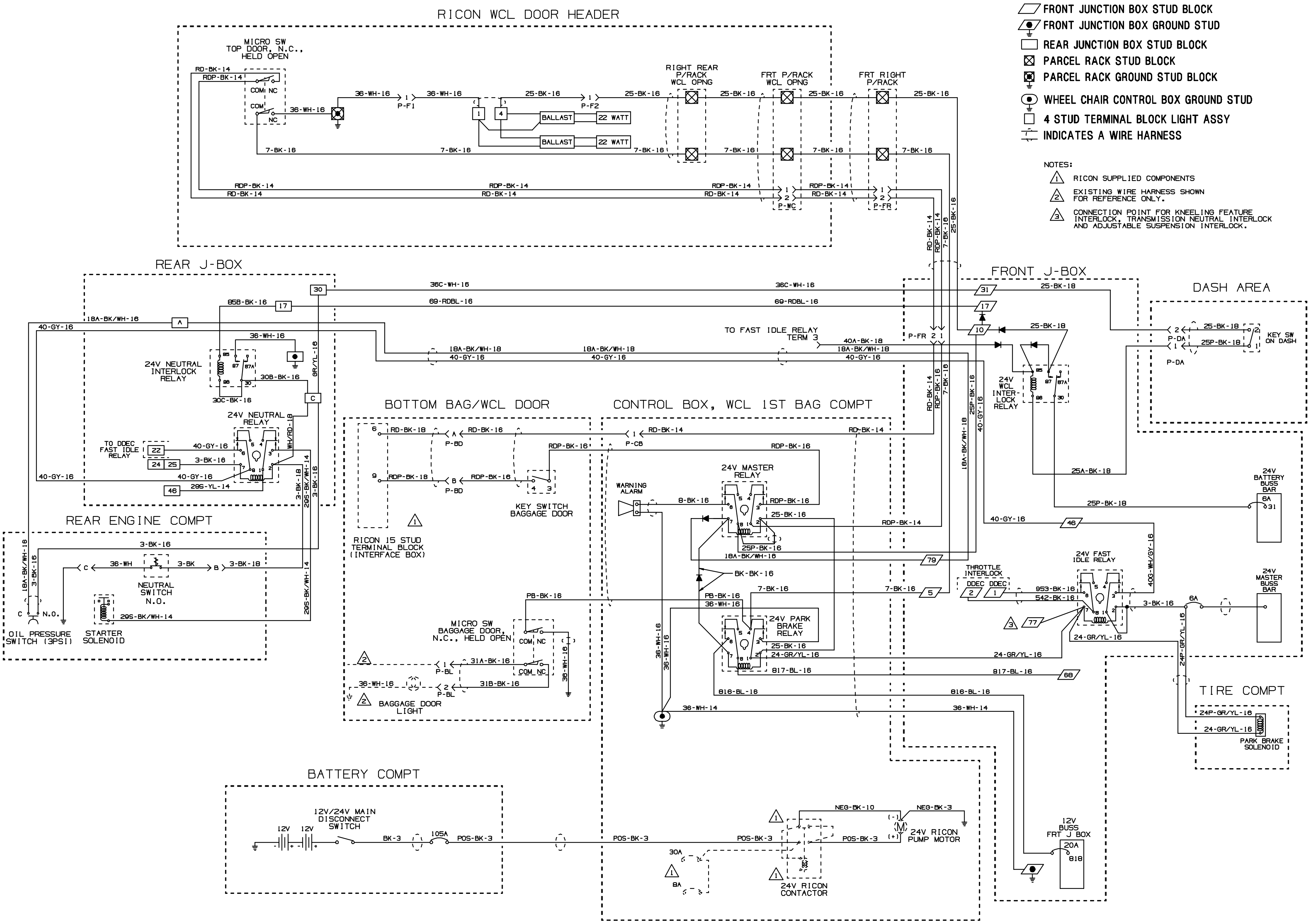
▱	FRT J—BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱	FRONT J—BOX STUD	○	ENGINE CRADLE STUD
▱○	FRT J—BOX ENT STUD BLK	⬡ IL	BEHIND DASH ILLUM STUD
▭	REAR J—BOX STUD BLOCK	⬡ B+	BEHIND DASH B+ STUD
▭	REAR J—BOX STUD	⬡ ⏚	BEHIND DASH GND STUD
△	A/C J—BOX STUD BLOCK	⍓	DEST SIGN STUD BLOCK
⊠	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J—BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J—BOX VERT STUD BLK	— —	OPTION

WH—WHITE
GY—GREY
VO—VIOLET
BL—BLUE

GR—GREEN
YL—YELLOW
OR—ORANGE

RD—RED
BR—BROWN
BK—BLACK

LEGEND


FRONT JUNCTION BOX STUD BLOCK
FRONT JUNCTION BOX GROUND STUD
REAR JUNCTION BOX STUD BLOCK
PARCEL RACK STUD BLOCK
PARCEL RACK GROUND STUD BLOCK
WHEEL CHAIR CONTROL BOX GROUND STUD
4 STUD TERMINAL BLOCK LIGHT ASSY
INDICATES A WIRE HARNESS
RICON WCL DOOR HEADER
MICRO SW TOP DOOR, N.C., HELD OPEN
COM
NC
BALLAST
22 WATT
RIGHT REAR P/RACK WCL OPNG
FRT P/RACK WCL OPNG
FRT RIGHT P/RACK
P-F1
P-F2
P-WC
P-FR
RD-BK-14
RDP-BK-14
36-WH-16
25-BK-16
7-BK-16
REAR J-BOX
24V NEUTRAL INTERLOCK RELAY
24V NEUTRAL RELAY
TO DDEC FAST IDLE RELAY
85B-BK-16
36C-WH-16
69-RDBL-16
18A-BK/WH-16
40-GY-16
30B-BK-16
30C-BK-16
6R/YL-16
WH/RD-18
3-BK-16
29S-YL-14
29S-BK/WH-14
REAR ENGINE COMPT
OIL PRESSURE SWITCH (3PSI)
NEUTRAL SWITCH N.O.
STARTER SOLENOID
36-WH
3-BK
3-BK-18
BOTTOM BAG/WCL DOOR
RICON 15 STUD TERMINAL BLOCK (INTERFACE BOX)
KEY SWITCH BAGGAGE DOOR
MICRO SW BAGGAGE DOOR, N.C., HELD OPEN
BAGGAGE DOOR LIGHT
P-BD
P-BL
RD-BK-18
RDP-BK-18
PB-BK-16
31A-BK-16
31B-BK-16
CONTROL BOX, WCL 1ST BAG COMPT
P-CB
WARNING ALARM
24V MASTER RELAY
24V PARK BRAKE RELAY
8-BK-16
25P-BK-16
BK-BK-16
24-GR/YL-16
817-BL-16
816-BL-16
36-WH-14
FRONT J-BOX
TO FAST IDLE RELAY TERM 3
24V WCL INTER-LOCK RELAY
40A-BK-18
18A-BK/WH-18
40-GY-16
25-BK-18
25A-BK-18
25P-BK-18
THROTTLE INTERLOCK
DDEC
24V FAST IDLE RELAY
953-BK-16
542-BK-16
40G-WH/GY-16
24P-GR/YL-16
6A
DASH AREA
P-DA
KEY SW ON DASH
24V BATTERY BUSS BAR
24V MASTER BUSS BAR
TIRE COMPT
PARK BRAKE SOLENOID
12V BUSS FRT J BOX
20A
BATTERY COMPT
12V/24V MAIN DISCONNECT SWITCH
12V
105A
BK-3
POS-BK-3
NEG-BK-10
NEG-BK-3
24V RICON PUMP MOTOR
24V RICON CONTACTOR
30A
8A
NOTES:

1. RICON SUPPLIED COMPONENTS

2. EXISTING WIRE HARNESS SHOWN FOR REFERENCE ONLY.

3. CONNECTION POINT FOR KNEELING FEATURE INTERLOCK, TRANSMISSION NEUTRAL INTERLOCK AND ADJUSTABLE SUSPENSION INTERLOCK.

SECTION 8

ENGINE

This section consists of seven primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The seven primary subsections are:

A1 - Engine Installation (Detroit Diesel 8V-92TA)
A2 - Engine Installation (Detroit Diesel Series 60)
A3 - Engine Installation (Cummins M-11 Command)
A4 - Engine Installation (Caterpillar 3176B & C-10)
B - Cold Weather Starting
C - Electronic Engine Control Systems
D - Jacobs Engine Brake System

SECTION 8A1

ENGINE INSTALLATION (DETROIT DIESEL 8V-92TA)

CONTENTS OF THIS SECTION

SUBJECT **PAGE**

General Description 8A1-1
Engine Specifications 8V-92TA 8A1-2
Miscellaneous Engine Torque Valves 8A1-6
Service Tools 8A1-7

GENERAL DESCRIPTION

The 8V-92 is a two-stroke cycle, right hand rotation, high speed low torque engine. This engine utilizes a turbo-charged air blower for optimum engine aspiration, and DDEC II's electronic control system for efficient operation.

The basic differences between the 8V-92 and other D series diesel power installations are as follows. The design of the cast iron block uses an opposing cylinder bank arrangement, with dual camshafts. The camshafts actuate the four exhaust valve rocker assemblies, and the one fuel injector rocker per cylinder in each of the two cast iron heads. The left-hand or right-hand cylinder head's rocker assemblies are operated only by it's respective camshaft via the pushrods. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshafts, fuel pump, water pump, air compressor drive and alternator accessory drive.

Each engine and transmission power module is equipped with an oil cooler, two fuel oil filters, starting motor, air compressor, water pump, turbocharger and the DDEC II electronic engine control system. Depending on the transmission, the engine could be fitted with either dual full-flow oil filters, or a single full-flow filter with an optional bypass filter system.

Full pressure lubrication is supplied to the blower drive, all main, connecting rod and camshaft bearings within the cylinder block, and all moving parts within each of the cylinder heads engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the oil filters. From the filters the oil flows through the oil cooler assembly, into the block's oil gallery. A small portion of oil is delivered to the turbocharger by an external oil line. The remainder of the oil flows through passages that connect with the cylinder heads for distribution to the valve and injector rocker arm mechanisms.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the primary fuel filter by a gear-type fuel pump. It is then forced through the secondary fuel filter and into the fuel inlet in the cylinder heads and finally to the injectors. The injector's fuel charge is metered, and timing controlled by the ECM, they are pumped to injection pressure and fired by the injector rocker arm. Excess fuel from the injectors is returned, through a restricted fitting, to the fuel tank via the outlet manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine exhaust gas. The air then flows into the blower assembly and compressed further. The heated and compressed air then flows through the aftercooler assembly where it is cooled before entering the cylinders via the air box and cylinder liner ports.

Some general specifications of this engine are shown in the following chart.

ENGINE SPECIFICATIONS

8V-92TA

Type	2 Cycle
Number of Cylinders	8
Bore (inches)	4.84
Bore (mm)	123
Stroke (inches)	5
Stroke (mm)	127
Comp. Ratio	17:1
Total Displacement (inches)	736
Total Displacement (mm)	12.07
Number of Main Bearings	5
Rated Full Load Speed (RPM)	2100

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual.

Refer to Section 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication).

To conform with engine manufacturer's practice, MCI Parts Book, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as "Left-Hand", "Right-Hand", "Front" or "Rear" when viewing the engine from the flywheel end. This is opposite to the position of these parts with the engine installed in the coach, but the engine manufacturer's designations have been retained to eliminate potential misunderstanding in engine parts identification.

All other parts of the coach are designed "Left-Hand", "Right-Hand", "Front" or "Rear" in relation to the normal position of the driver facing forward.

ENGINE MODULE REMOVAL

The power module (Figure 1) including engine, transmission, clutch, air compressor, starter, alternator and all filtration systems, may be removed from the coach as a unit for repair or inspection of components. Follow removal procedure in order.

NOTE: To facilitate removal and replacement of the engine module, and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of dolly P/N 20-340 (Figure 5).

1. After coach is positioned on a twin-rail hoist of capacity, placed blocks between axle bumpers and bumper stops to stabilize axle during bellows deflation.
2. Turn main battery switch to "OFF".
3. Disconnect height control valve links and pull down to vent air from rear suspension bellows.
4. Disconnect the drive shaft as outlined in Section 14 of this manual.
5. Drain the engine cooling system as directed in Section 6 of this manual.
6. Remove the cooling fan drive belts.
7. Remove the air conditioning compressor drive belts.
8. Open drain cock on the ping tank, and vent air from the wet tank.
9. Disconnect discharge air line from air compressor.
10. Disconnect compressor governor air lines from air/fuel junction block.
11. Disconnect fuel supply and return lines at air/fuel junction block.
12. Disconnect exhaust and air cleaner pipe clamps from turbocharger housing.
13. Disconnect exhaust muffler slip joint and remove exhaust pipe section.
14. Disconnect and remove air cleaner pipe section from turbocharger housing's inlet
15. Completely disconnect and remove the return water pipe sections from radiator to engine water pump, including the make-up water pipe from surge tank and coach center tunnel return pipe at lower front of engine.
16. Completely disconnect and remove radiator inlet pipe sections from left and right cylinder head thermostat housings to radiator assembly.
17. Disconnect coach center tunnel supply pipe from left and right engine block tube assembly at hose connection.
18. Disconnect ground cable.
19. Disconnect starter cable.
20. Disconnect alternator wiring and mark.
21. Disconnect all input or output coach wiring harnesses of the DDEC system's ECM and mark, including the main DDEC harness at ECM.
22. Disconnect the ATEC system's main coach harness at transmission.
23. Disconnect all coach water temperature gauge and switch wire harnesses on thermostat housing.
24. Disconnect Transmission shift cable (HT-740 Trans).
25. Disconnect transmission shift linkage (Standard Trans).

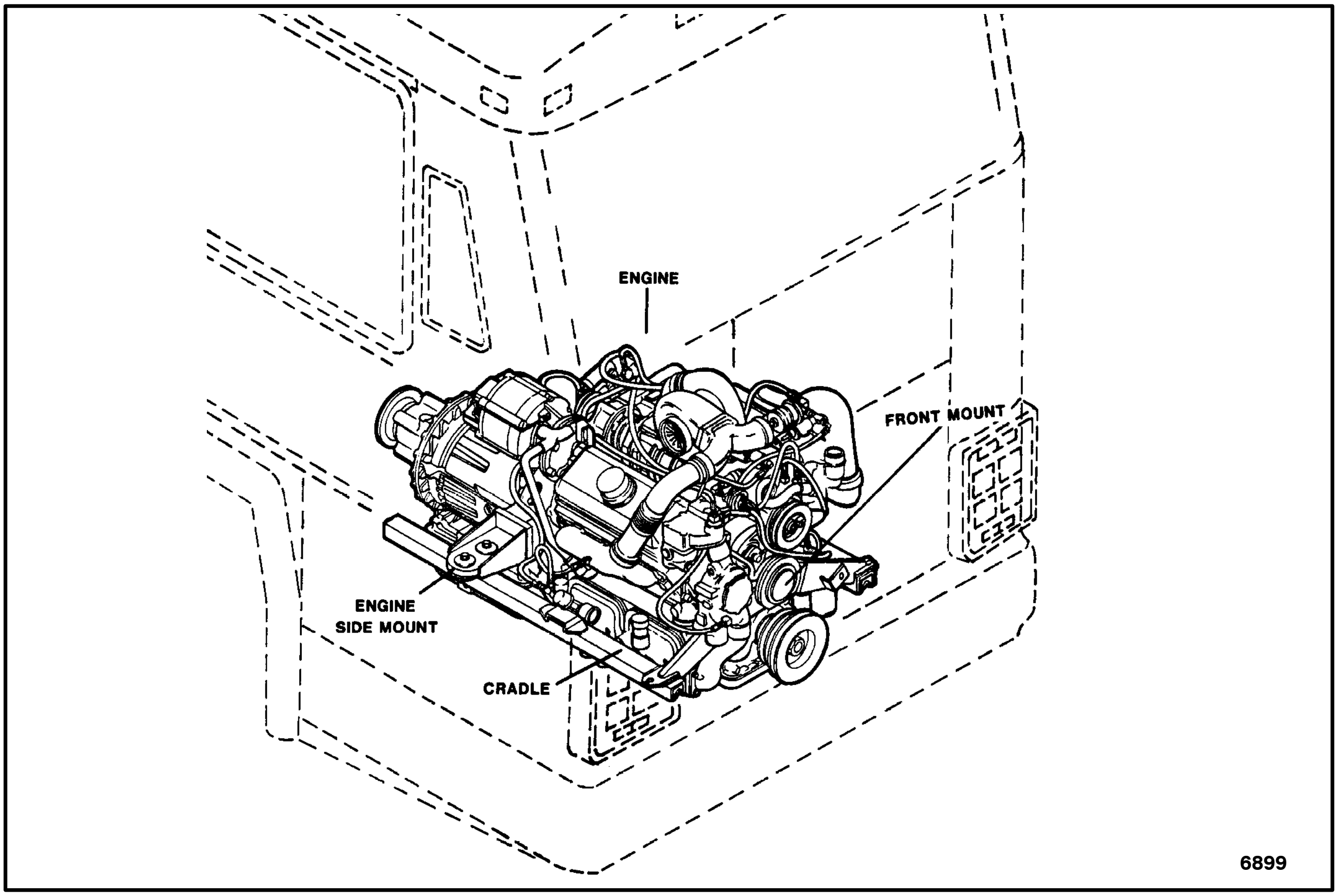


Figure 1. 8V92 Installation

26. Disconnect clutch cable (Standard Trans).

27. Remove the rear bumper.

28. Raise the coach approximately 4-6 inches (101.6-152.4 mm) above floor.

29. Remove the clamp bolts securing the engine craddle to the coach motor rails.

30. Position the dolly under the engine.

31. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

⚠ CAUTION ⚠

Due to the minimum clearance between the air compressor and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be ⅛-¼ inch (3.1-6.3 mm).

32. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach.

ENGINE MODULE INSTALLATION

1. To reinstall, reverse the above procedure.
2. Refill cooling system.
3. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil.
4. Remove vent plugs and pour fuel oil into filter body until filters are full.
5. Start engine and check operation.
6. Check fuel and cooling system connections for leakage.
7. Test operation of engine controls and accessories.

DIESEL ENGINE LUBRICATING OILS

Coaches equipped with an 8V-92 engine have an oil capacity of 32 U.S. quarts (30.28 liters). Oil is added through the oil fill tube (Figure 2).

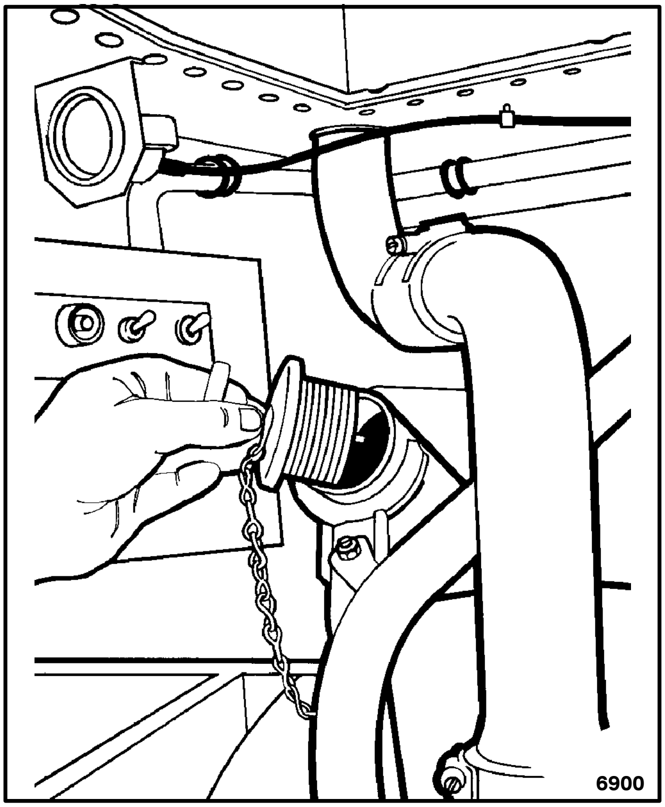


Figure 2. Oil Fill Tube

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. The optimum 8V-92 diesel engines are SAE 40 or 30 weight oil.

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term “oil supplier” is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation

API Service Code Classification	Military Specification	SAE Grade
CBMIL-L-2104A	(Supplement 1)	40 or 30
CC	MIL-L-2104B	40 or 30
CO/SC	MILL-2104C	40 or 30
CO	MIL-L-45199B (Series 3)	40 or 30
CC/SE	MIL-L-46152	40 or 30

SAE 40 grade oil is recommended in Series 92 diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil. Only when the ambient temperatures and engine cranking capabilities result in difficult starting should SAE 30 grade oil be used.

The Series 92 engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limit, (ASTMD-874), shall not exceed 1.0% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 40, or SAE 30 oils with auxiliary heating aids. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction reducing compounds.

NOTE: MCI warranty applicable to Series 92 diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, the service intervals noted in the Detroit Diesel Service Manual are minimum requirements that keep the engine warrant valid. Engine conditions may vary depending on the service environments from one coach to another, therefore, maintenance schedules should be formulated with the specific coach's service conditions in mind. Additionally, on the 8V-92 engine a good rule of thumb for piston, ring and liner inspection would be at 45,000 miles (54,000 km) or 1,500 hours for the first inspection and at 30,000 miles (45,000 km) or 1,000 hour intervals thereafter.

A suggested preventive maintenance practice includes a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Since the oil supplier knows the physical properties of his products and maintains laboratories to determine practical oil drain intervals, take advantage of this service and request a check of frequently drained oil samples and a report of the results.

ENGINE MOUNTS

The engine is mounted to the engine cradle with four sets of rubber mounts, two rear mounts attached to struts on each side of the transmission housing or engine flywheel housing (Figure 3). The two front mounts attached to the trunion plate on each side of the crankshaft (Figure 4). These rubber mounts should be inspected every 24 months or 60,000 to 96,000 miles, whichever comes first, and replaced if necessary using the following procedure.

NOTE: Mounts should be replaced only as complete sets (i.e. upper mount and lower snubber).

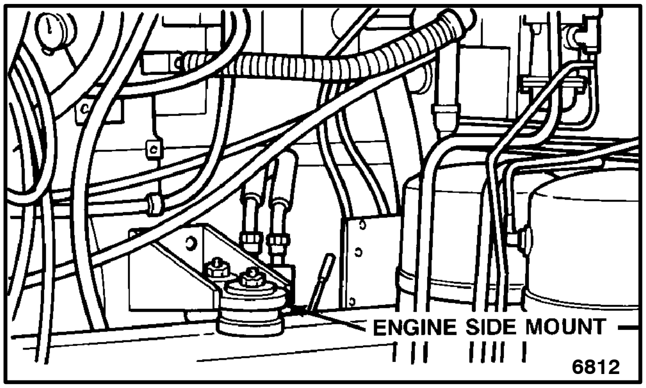


Figure 3. Rear Mount

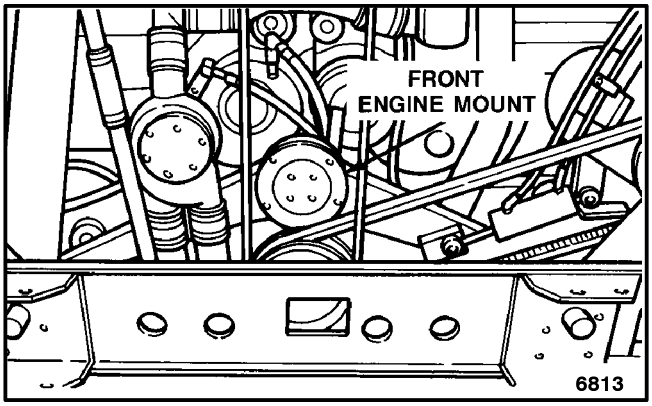


Figure 4. Front Mount

1. Unfasten and remove the damaged mount's bolting.

2. Loosen the other three mount bolts to allow damaged mount removal.

3. Position jack under engine and lift until clear of craddle and mount can be removed.

4. When replacing mounts, lubricate new rubber mount with soapy water and position on transmission bracket or craddle, and insert bolt to aid in setting mount.

⚠ CAUTION ⚠

To properly insert the engine mounts, only a soap and water mixture should be used as a lubricant. Positioning of the mount using glycerine or any other lubricant may result in a failure of the mount.

5. Gently lower engine down onto engine craddle to set mount correctly into.

6. Install lower engine mount snubber with new retaining washer, and hand tighten with full weight of engine bearing on cradle assembly.

CAUTION

Improper installation of the motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

If mount strut studs are installed in the transmission case, turn studs and check to ensure each has reached full thread engagement and snug up no more than ¼ turn. Mount strut bracket and torgue locknuts to specifications.

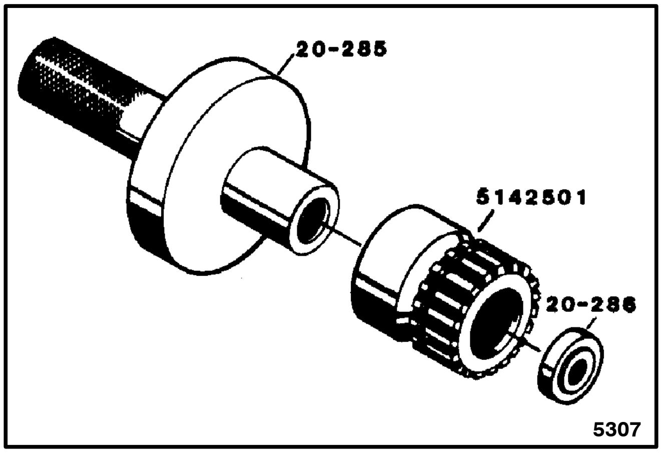
MISCELLANEOUS ENGINE TORQUE VALUES

(FOR COMPLETE ENGINE SPECIFICATIONS REFER TO THE APPROPRIATE DETROIT DIESEL ENGINE SERVICE MANUAL.)

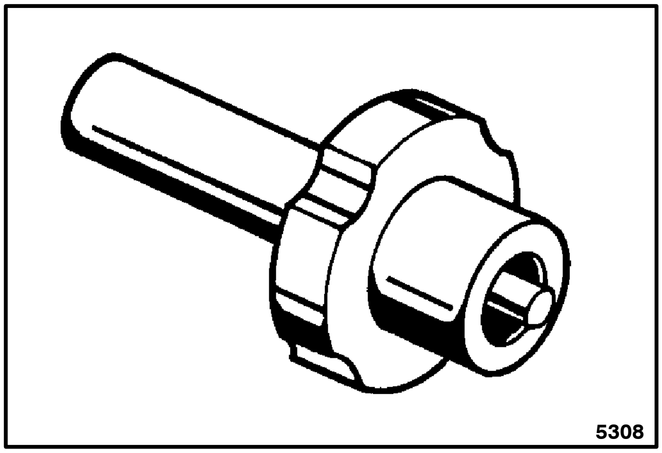
Front Motor Mount Bolts (Rear of Coach)	180 ft-lbs (244 N·m)
Rear Motor Mount Bolts	225 ft-lbs (305 N·m)
Rear Motor Mount Strut Locknuts (On Transmission)	170-198 ft-lbs (230-268 N·m)
Crankshaft Vibration Damper Bolts	75-85 ft-lbs (102-115 N·m)
Crankshaft End Bolt	290-310 ft-lbs (393-421 N·m)
Crankshaft Pulley Bolts	35-39 ft-lbs (47-52 N·m)
Oil Drain Plug	33-37 ft-lbs (45-50 N·m)
Starter Mounting Bolts	138-154 ft-lbs (187-209 N·m)
Air Compressor Housing-to-Gear Case Bolts	43-54 ft-lbs (58-73 N·m)
Adapter and Steering Pump-to-Gear Case Bolts	25-30 ft-lbs (35-40 N·m)
Adapter and Alternator-to-Gear Case Bolts	25-30 ft-lbs (35-40 N·m)

SERVICE TOOLS

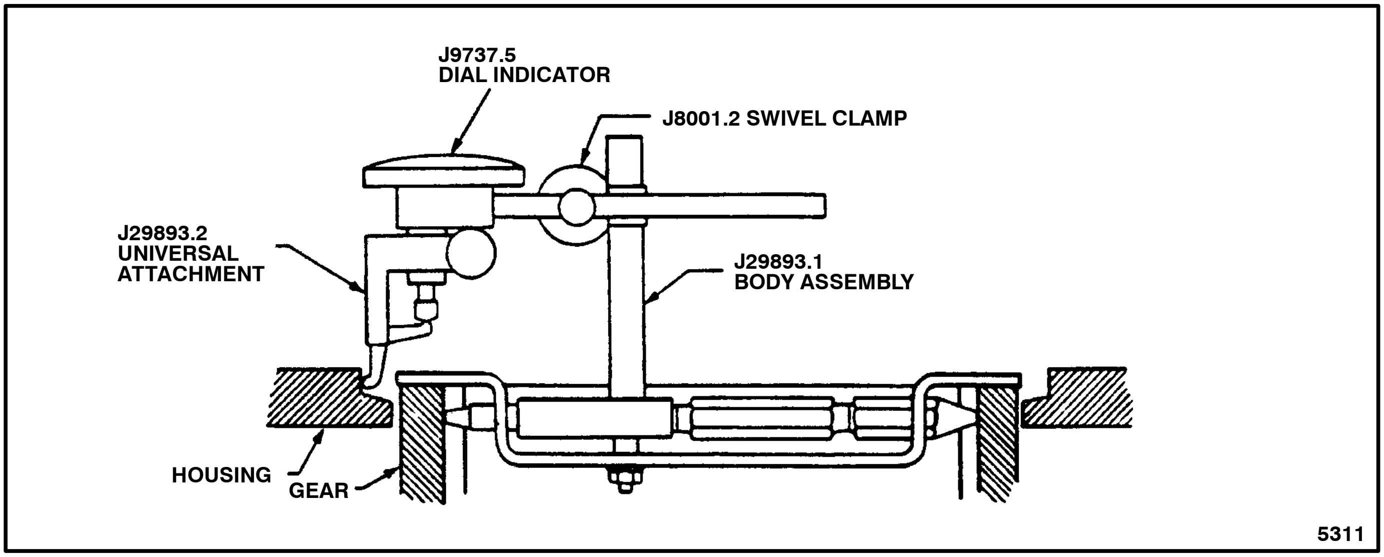
MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.


20-285
5142501
20-286
5307

Alignment Tool 20-157 (Nut-Mounted Cam Gear)

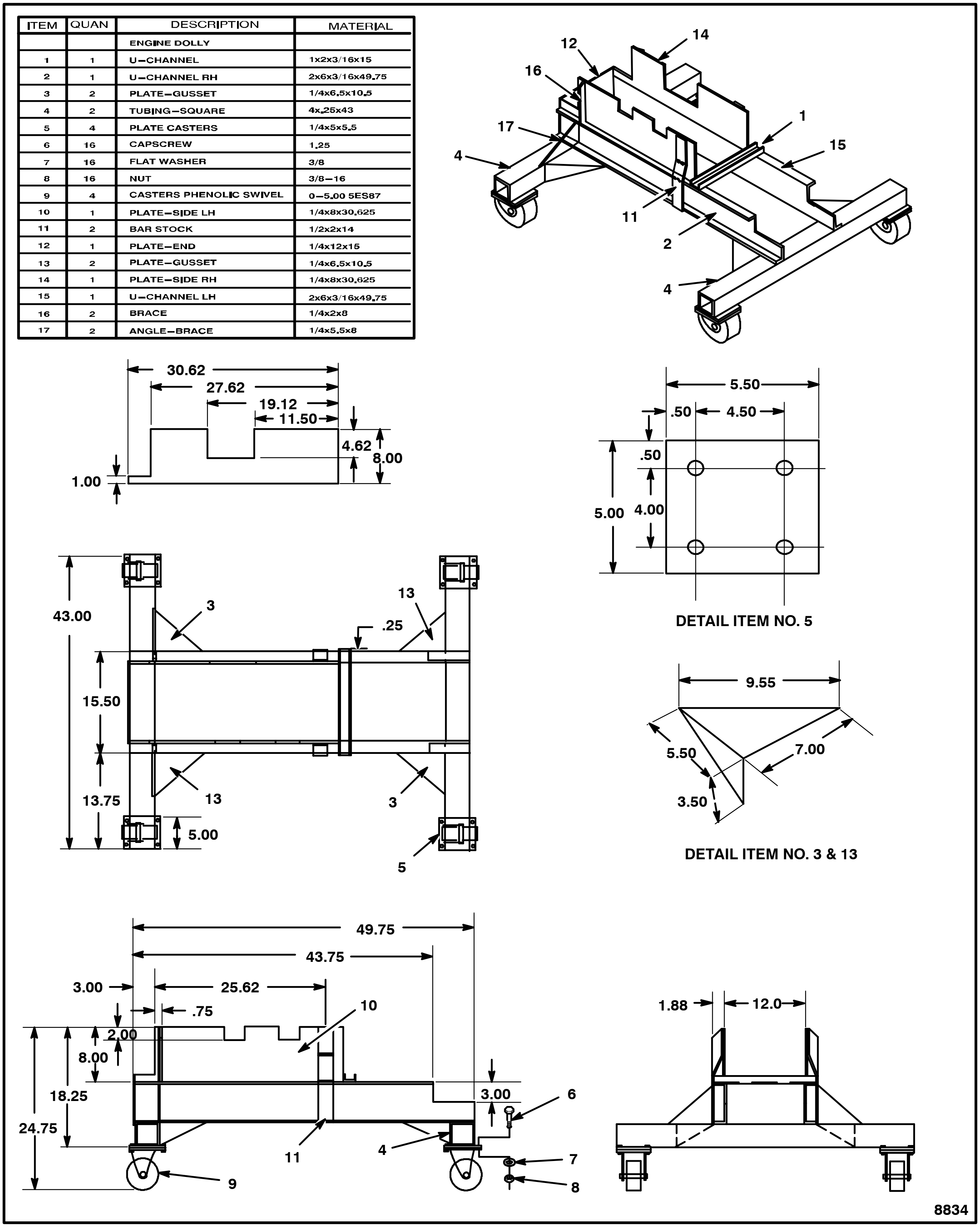


Alignment Tool (Capscrew-Mounted Cam Gear)


J9737.5
DIAL INDICATOR
J8001.2 SWIVEL CLAMP
J29893.2
UNIVERSAL
ATTACHMENT
J29893.1
BODY ASSEMBLY
HOUSING
GEAR
5311

Dial Indicator and Mounting Tool

ITEM	QUAN	DESCRIPTION	MATERIAL
		ENGINE DOLLY	
1	1	U–CHANNEL	1x2x3/16x15
2	1	U–CHANNEL RH	2x6x3/16x49.75
3	2	PLATE–GUSSET	1/4x6.5x10.5
4	2	TUBING–SQUARE	4x.25x43
5	4	PLATE CASTERS	1/4x5x5.5
6	16	CAPSCREW	1.25
7	16	FLAT WASHER	3/8
8	16	NUT	3/8–16
9	4	CASTERS PHENOLIC SWIVEL	0–5.00 5ES87
10	1	PLATE–SIDE LH	1/4x8x30.625
11	2	BAR STOCK	1/2x2x14
12	1	PLATE–END	1/4x12x15
13	2	PLATE–GUSSET	1/4x6.5x10.5
14	1	PLATE–SIDE RH	1/4x8x30.625
15	1	U–CHANNEL LH	2x6x3/16x49.75
16	2	BRACE	1/4x2x8
17	2	ANGLE–BRACE	1/4x5.5x8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1.00
5.50
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5.00
4.00
DETAIL ITEM NO. 5
43.00
3
13
.25
15.50
13.75
13
3
5.00
5
9.55
5.50
7.00
3.50
DETAIL ITEM NO. 3 & 13
49.75
43.75
3.00
25.62
.75
10
2.00
8.00
18.25
24.75
3.00
6
11
4
7
9
8
1.88
12.0
8834

Figure 5. Engine Dolly

SECTION 8A2

ENGINE INSTALLATION (DETROIT DIESEL SERIES 60)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	8A2-1
Engine Specifications Series 60 (425 HP)	8A2-2
Maintenance	8A2-2
Miscellaneous Engine Torque Values	8A2-6
Service Tools	8A2-7
Specifications	8A2-8

GENERAL DESCRIPTION

The Series 60 are four-stroke cycle, right hand rotation, high speed high torque engines (325/350/370 or 425 HP). These engines utilize a turbo-charged air intake manifold for optimum engine aspiration, and DDEC II or III electronic control system for efficient operation.

The Series 60 utilizes an in-line cast iron block, together with a cast iron head containing a single overhead camshaft. The camshaft actuates the two inlet and exhaust valve rocker assemblies, and the one fuel injector rocker per cylinder. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshafts, water pump, air compressor drive and alternator accessory drive. The fuel pump is driven by the rear drive of the air compressor.

Each engine module is equipped with an oil cooler, two fuel oil filters, a starting motor, air compressor, water pump, turbocharger and the DDEC II electronic engine control system. Additionally, the engine is fitted with dual full-flow oil filters, and can be fitted with an optional bypass filter.

Full pressure lubrication is supplied to all main, connecting rod bearings and other moving parts within the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the two 28 micron oil filters, from the filter, a small portion is delivered to the turbocharger by an external oil line. The remainder of the filtered oil is delivered to the oil cooler, or bypasses the cooler, and enters the block's oil gallery. This gallery feeds oil to the cylinder head's camshaft bearings and rocker assemblies, and the remainder lubricates the main and connecting rod bearings. Internal oil passages in the connecting rods and pistons lubricate the piston pin and cool the piston crown.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the primary fuel filter by a gear-type fuel pump. It is then forced through the secondary fuel filter and into the fuel inlet in the cylinder heads and finally to the injectors. Excess fuel from the injectors is returned, through a restricted fitting, to the fuel tank via the outlet manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine's exhaust gas. The air then flows through the Charge-Air-Cooler in the radiator assembly, where it is cooled and returned to the intake manifold. The cooled air charge is then introduced into each cylinders with the engine's intake strokes.

Some general specifications of this engine are shown in the following chart.

ENGINE SPECIFICATIONS

SERIES 60 (425 HP)

Type	4 cycle
Number of Cylinders	6
Bore (inches)	5.12
Bore (mm)	130
Stroke (inches)	6.3
Stroke (mm)	160
Comp. Ratio	15:1
Total Displacement (inches)	775
Total Displacement (mm)	12.7
Number of Main Bearings	7
Rated Full Load Speed (RPM)	2100

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual.

Refer to Section 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication).

MCI Parts Books, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as "Left-Hand", "Right-Hand", "Front" or "Rear" when viewing the engine from the flywheel end. This is opposite to the position of these parts with respect to a coach installation. All parts of the coach are designated "Left-Hand", "Right-Hand", "Front" or "Rear" in relation to the normal position of the driver facing forward. Engine manufacturer's designations have been retained to eliminate potential problems in engine parts identifications and locating.

MAINTENANCE

ENGINE MODULE REMOVAL

The power module (Figure 1) including transmission, clutch, air compressor and alternator, may be removed from the coach as a unit for repair to engine or related components. Follow the removal procedure in order.

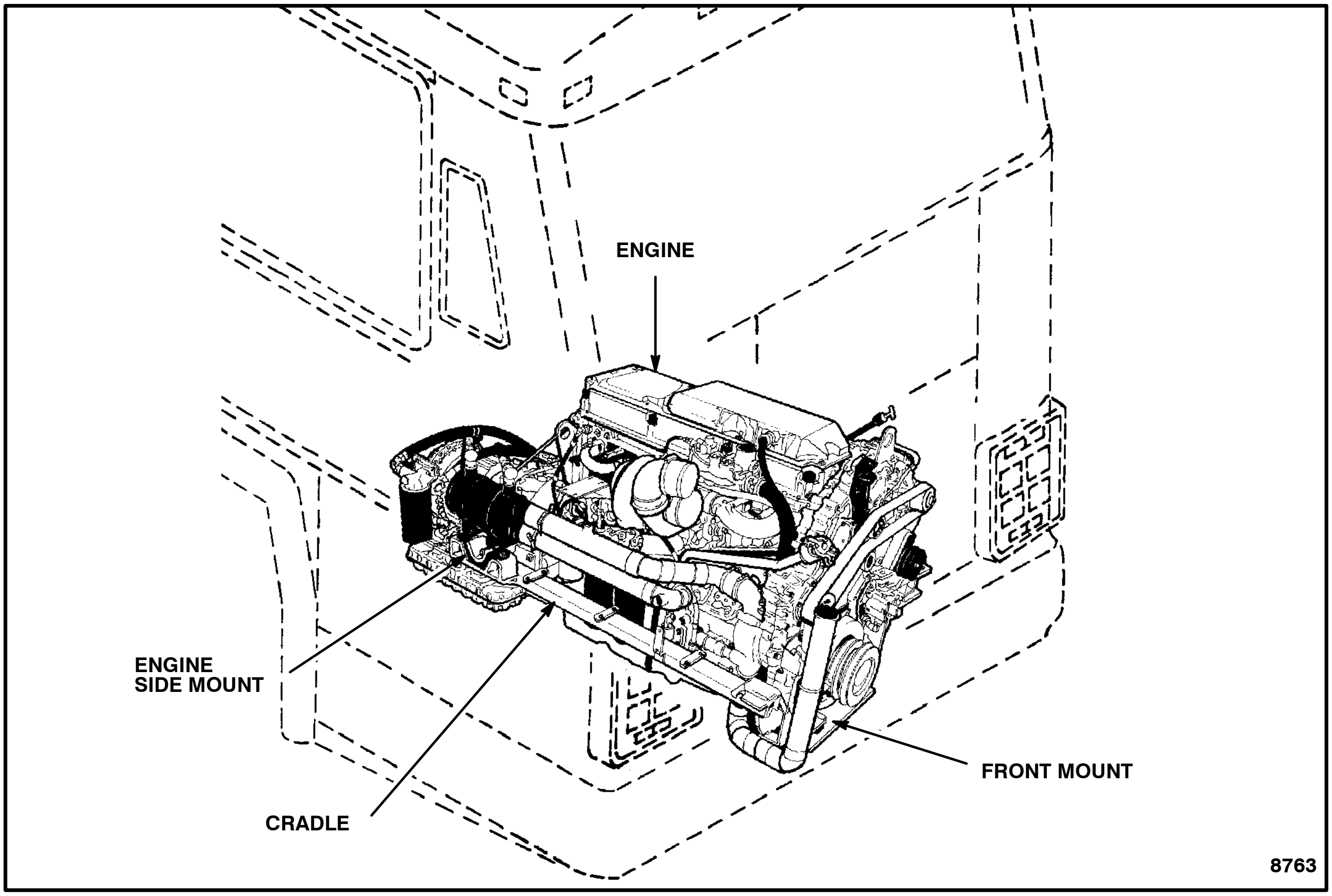


Figure 1. Power Module

NOTE: To facilitate removal and replacement of the engine module, and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly/engine stand is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of dolly/engine stand P/N's 20-382/20-386 (Figure 5).

1. After coach is positioned on a twin-rail hoist of capacity, place blocks between axle bumpers and bumper stops to stabilize axle during bellows deflation.
2. Turn main battery switch to "OFF".
3. Disconnect height control valve links and pull down to vent air from rear suspension bellows.
4. Disconnect the drive shaft as outlined in Section 14 of this manual.
5. Drain the engine cooling system as directed in Section 6 of this manual.
6. Remove the cooling fan drive belts.
7. Remove the air conditioning compressor drive belts.
8. Open drain cock on the ping tank, and vent air from the wet tank.
9. Disconnect discharge air line from air compressor.
10. Disconnect compressor governor air lines from air/fuel junction block.
11. Disconnect fuel supply and return lines at air/fuel junction block.
12. Disconnect exhaust and air cleaner pipe clamps from turbocharger housing.
13. Disconnect exhaust muffler slip joint and remove exhaust pipe section.
14. Disconnect and remove air cleaner pipe section from turbocharger housing's inlet
15. Disconnect and remove the charge air inlet pipe from the turbocharger housing's outlet.
16. Disconnect and remove the charge air outlet pipe from intake manifold.
17. Disconnect Webasto heater's exhaust pipe from engine craddle.
18. Disconnect and remove Webasto heater's water inlet pipe section from engine oil cooler fitting.
19. Disconnect and remove the return water pipe section from engine water pump fitting.
20. Disconnect and remove water pump inlet pipe section from radiator assembly.
21. Disconnect and remove thermostat outlet pipe section from radiator assembly.
22. Disconnect and remove make-up water pipe from surge tank to water pump.
23. Disconnect ground cable.
24. Disconnect starter cable.
25. Disconnect alternator wiring and mark.
26. Disconnect all input or output coach wiring harnesses of the DDEC system's ECM and mark, including the main DDEC harness at ECM.
27. Disconnect the ATEC system's main coach harness at transmission.
28. Disconnect all coach water temperature guage and switch wire harnesses on thermostat housing.
29. Disconnect Transmission shift cable (HT-740 Trans).
30. Disconnect transmission shift linkage (Standard Trans).
31. Disconnect clutch cable (Standard Trans).
32. Remove the rear bumper.
33. Raise the coach approximately 4-6 inches (101.6-152.4 mm) above floor.
34. Remove the clamp bolts securing the engine sub-frame to the coach body.
35. Position the dolly under the engine cradle.
36. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

⚠ CAUTION ⚠

Due to the minimum clearance between the air compressor and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be ⅛-¼ inch (3.1-6.3 mm).

37. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach.

ENGINE MODULE INSTALLATION

1. To reinstall, reverse the above procedure.
2. Refill cooling system.
3. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil.
4. Remove vent plugs and pour fuel oil into filter body until filters are full.
5. Start engine and check operation.
6. Check fuel and cooling system connections for leakage.
7. Test operation of engine controls and accessories.

DIESEL ENGINE LUBRICATING OILS

Coaches equipped with a Series 60 engine have an oil capacity of 38 U.S. quarts (39.9 liters). Oil is added through the oil fill tube (Figure 2).

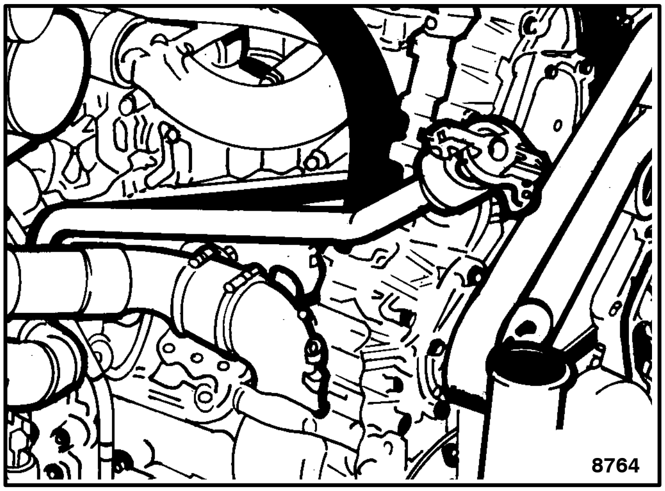


Figure 2. Oil Fill Tube

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. **The only lubricating oil recommended for Series 60 diesel engines is the API Service Code CF4 - SAE 15W-40.**

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

SYNTHETIC OILS

Synthetic oils may be used in Detroit Diesel engines, provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils. Synthetic oils offer improved low temperature flow properties and high temperature oxidation resistance.

Product information about synthetic oils should be reviewed carefully. Performance additives often respond differently in synthetic oils. The use of synthetic oil does not permit extension of recommended oil drain intervals.

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term “oil supplier” is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation

API Service Code Classification	Military Specification	SAE Grade
CF-4		15W-40

SAE 15W-40 grade oil is recommended in the Series 60 diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil.

NOTE: Monograde oils should not be used in these engines regardless of API Service Classification.

The Series 60 engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limit (ASTMD-874) shall not exceed 1.0% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 15W-40 with auxiliary heating. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction reducing compounds.

> **NOTE:** MCI warranty applicable to Series 60 diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, the service intervals noted in the Detroit Diesel Service Manual are minimum requirements to keep the engine warrant valid. Engine conditions may vary depending on the service environments from one coach to another, therefore, maintenance schedules should be formulated with the specific coach's service conditions in mind.

A suggested preventive maintenance practice includes a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Since the oil supplier knows the physical properties of his products and maintains laboratories to determine practical oil drain intervals, take advantage of this service and request a check of frequently drained oil samples and a report of the results.

ENGINE MOUNTS

The engine is mounted to the engine cradle with four sets of rubber mounts, two rear mounts attached to struts on each side of the flywheel housing (Figure 3), and two front mounts attached to the trunion plate on each side of the crankshaft (Figure 4). These rubber mounts should be inspected every 24 months or 60,000 to 96,000 miles, whichever comes first, and replaced if necessary using the following procedure.

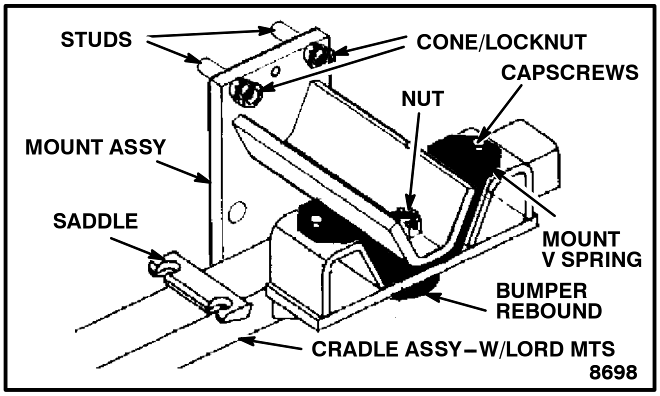


Figure 3. Rear Mount

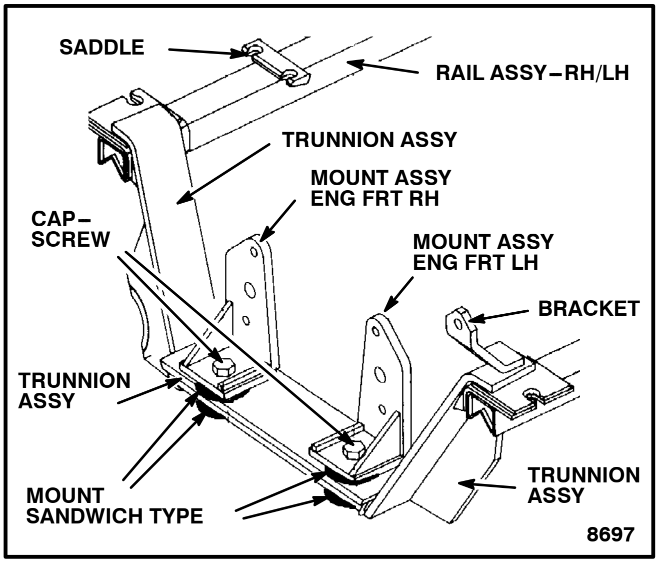


Figure 4. Front Mount

> **NOTE:** Mounts should be replaced only as complete sets (i.e. upper mount and lower snubber).

1. Unfasten and remove the damaged mount's bolting, and loosen all other mount fasteners to allow its removal.

2. Position jack under engine and lift until clear of cradle and mount can be removed.

3. When replacing rear mounts, lubricate new rubber mount with soapy water and position on engine strut bracket, and insert bolt to aid in setting mount.

⚠ CAUTION ⚠

To properly insert the engine mounts, only a soap and water mixture should be used as a lubricant. Positioning of the mount using glycerine or any other lubricant may result in a failure of the mount.

4. Gently lower engine down onto engine craddle to set mount correctly into.

5. Install lower engine mount snubber with new retaining washer, and hand tighten with full weight of engine bearing on cradle assembly.

⚠ CAUTION ⚠

Improper installation of the motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

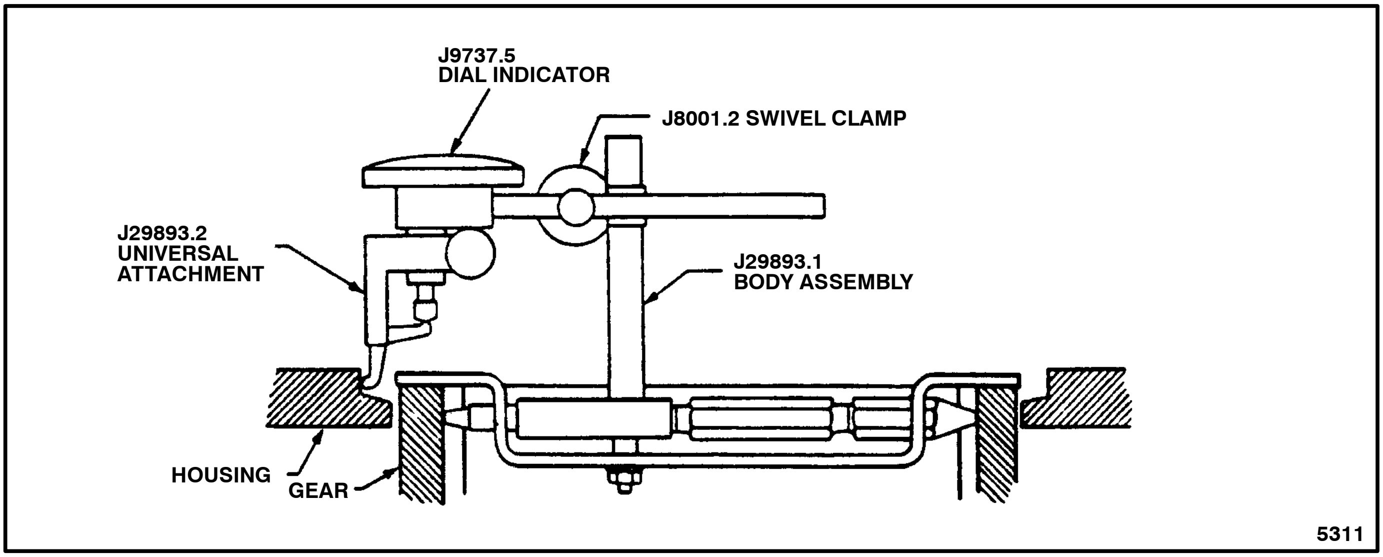
MISCELLANEOUS ENGINE TORQUE VALUES

(FOR COMPLETE ENGINE SPECIFICATIONS REFER TO THE APPROPRIATE DETROIT DIESEL ENGINE SERVICE MANUAL.)

Front Motor Mount Bolts (Rear of Coach)	180 ft-lbs (244 N·m)
Rear Motor Mount Bolts	225 ft-lbs (305 N·m)
Rear Motor Mount Strut-to Engine Locknuts	43-54 ft-lbs (58-73 N·m)
Crankshaft Vibration Damper Bolts	134-155 ft-lbs (182-210 N·m)
Crankshaft Pulley Bolts	134-155 ft-lbs (182-210 N·m)
Oil Drain Plug	33-37 ft-lbs (45-50 N·m)
Alternator Belt Pulley Tensioning Bracket Bolts	75-93 ft-lbs (101-126 N·m)
Alternator Mounting Bracket Bolts	43-54 ft-lbs (58-73 N·m)
Starter Mounting Bolts	138-154 ft-lbs (187-209 N·m)
Air Compressor Housing-to-Gear Case Bolts	43-54 ft-lbs (58-73 N·m)
Adapter and Steering Pump-to-Gear Case Bolts	43-54 ft-lbs (58-73 N·m)

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.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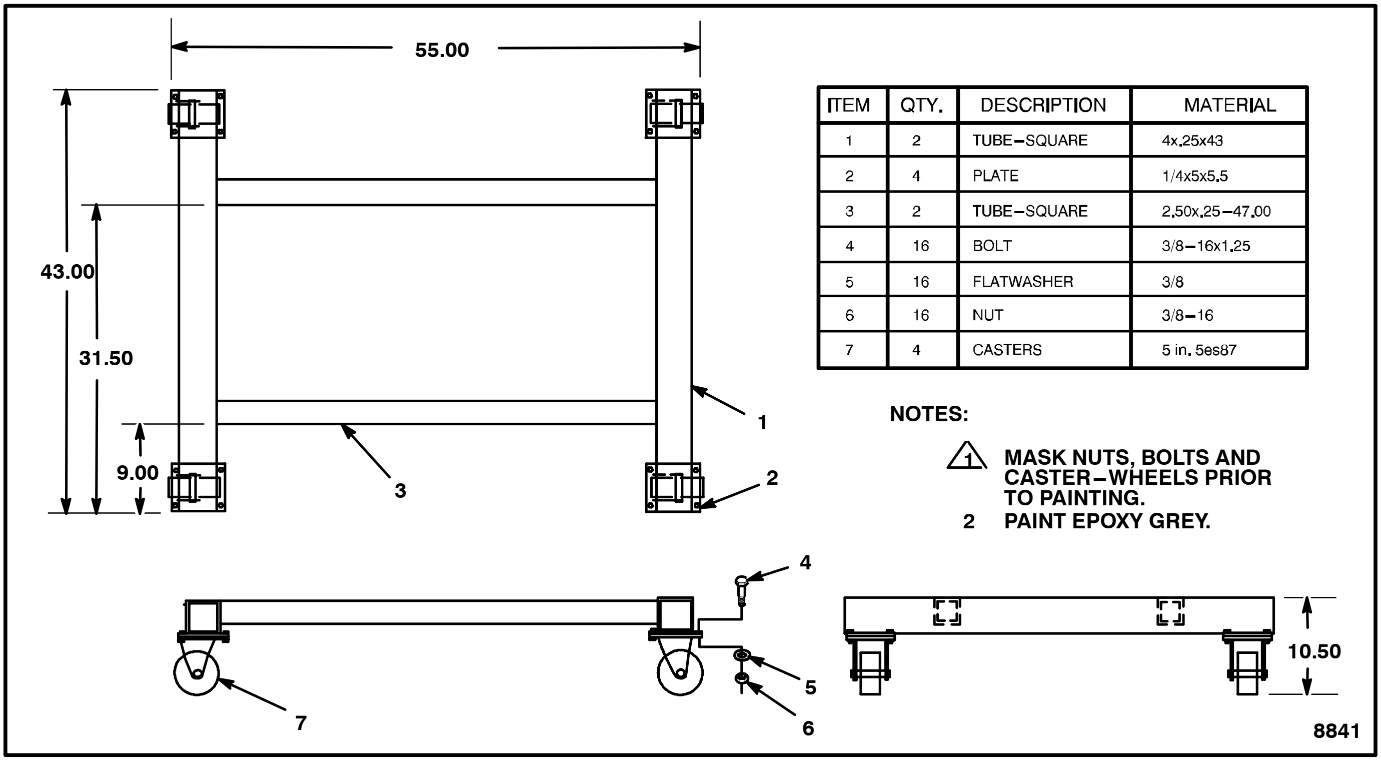
UNIVERSAL
ATTACHMENT
J29893.1
BODY ASSEMBLY
HOUSING
GEAR
5311

Dial Indicator and Mounting Tool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ITEM	QTY.	DESCRIPTION	MATERIAL
1	2	TUBE–SQUARE	4x.25x43
2	4	PLATE	1/4x5x5.5
3	2	TUBE–SQUARE	2.50x.25–47.00
4	16	BOLT	3/8–16x1.25
5	16	FLATWASHER	3/8
6	16	NUT	3/8–16
7	4	CASTERS	5 in. 5es87

NOTES:

1. **MASK NUTS, BOLTS AND CASTER–WHEELS PRIOR TO PAINTING.**
2. **PAINT EPOXY GREY.**

Figure 5. Engine Dolly (P/N 20-382)(Use with P/N 20-386)

SPECIFICATIONS

OIL FILTER ASSEMBLY (W/OLD STYLE TWO FILTER & ONE BY-PASS SYSTEM)

Part Number	25010495 (Detroit Diesel)
Part Number (By-Pass Filter)	25011188 (Detroit Diesel)
Part Number	PF911L (A/C Delco)
Part Number (By-Pass Filter)	PF940 (A/C Delco)

OIL FILTER ASSEMBLY (W/NEW STYLE TWO FILTER SYSTEM)

Part Number	25014505 (Detroit Diesel)
Part Number	PF2100 (A/C Delco)
Design	Spin-On Full-Flow (28 Micron)
Location	(Filter Head Mounted) LH Side of Coach

FUEL FILTER ASSEMBLY (PRIMARY)

Part Number	25011910 (Detroit Diesel)
Part Number	TP1057 (A/C Delco)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

FUEL FILTER ASSEMBLY (SECONDARY)

Part Number	25014342 (Detroit Diesel)
Part Number	TP916D (A/C Delco)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

WATER CHARGE FILTER ASSEMBLY

Part Number	23507189 (Detroit Diesel)
Part Number	3000 DD-60 (Nalcool)
Design	Spin-On
Location	(Filter Head Mounted) LH Side of Coach

SECTION 8A3

ENGINE INSTALLATION (CUMMINS M-11 COMMAND)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	8A3-1
Engine Specifications Cummins M-11 (370HP)	8A3-2
Maintenance	8A3-2
Service Tools	8A3-7
Miscellaneous Engine Torque Values	8A3-8
Specifications	8A3-8

GENERAL DESCRIPTION

The Cummins M-11 is a four-stroke cycle, right hand rotation, high speed (330 or 370 HP) high torque engine. This engine utilizes a turbo-charged air intake manifold for optimum engine aspiration, and Cummins CELECT™ electronic control system for efficient operation.

The Cummins M-11 utilizes an in-line cast iron block, together with a cast iron head containing a single overhead camshaft. The camshaft actuates the two inlet and exhaust valve rocker assemblies, and the one fuel injector rocker per cylinder. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshaft, power steering pump, water pump, air compressor drive and alternator accessory drive. The fuel pump is driven by the rear drive of the air compressor.

Each engine module is equipped with an oil cooler, one fuel filter assembly, a starting motor, air compressor, water pump, turbocharger and the CELECT™ electronic engine control system. Additionally, the engine is fitted with a single combination full-flow/by-pass oil filter and oil cooler assembly.

Full pressure lubrication is supplied to all main, connecting rod bearings and other moving parts within the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the oil filter, from the filter, a small portion is delivered to the turbocharger by an external oil line. The remainder of the filtered oil is delivered to the oil cooler, or bypasses the cooler, and enters the block's oil gallery. This gallery feeds oil to the cylinder head's camshaft bearings and rocker assemblies, and the remainder lubricates the main and connecting rod bearings.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the CELECT™ electronic engine control system's ECM, and then through the fuel filter and gear-type fuel pump. It is then forced into the fuel inlet in the cylinder heads and finally to the injectors. Excess fuel from the injectors is returned, through a restricted fitting, to the fuel tank via the outlet manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine's exhaust gas. The air then flows through the Charge-Air-Cooler in the radiator assembly, where it is cooled and returned to the intake manifold. The cooled air charge is then introduced into each cylinders with the engine's intake strokes.

Printed in U.S.A.

Some general specifications of this engine are shown in the following chart.

ENGINE SPECIFICATIONS

CUMMINS M-11 (370HP)

Type	4 cycle
Number of Cylinders	6
Bore (inches)	4.921
Bore (mm)	125
Stroke (inches)	5.787
Stroke (mm)	147
Comp. Ratio	16.1:1
Total Displacement (inches)	661
Total Displacement (mm)	10.8
Number of Main Bearings	7
Rated Full Load Speed (RPM)	2000

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual. Refer to Sections 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication).

MCI Parts Books, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as “Left-Hand”, “Right-Hand”, “Front” or “Rear” when viewing the engine from the flywheel end. This is opposite to the position of these parts with respect to a coach installation. All parts of the coach are designated “Left-Hand”, “Right-Hand”, “Front” or “Rear” in relation to the normal position of the driver facing forward. Engine manufacturer's designations have been retained to eliminate potential problems in engine parts identifications and locating.

MAINTENANCE

ENGINE MODULE REMOVAL

The power module (Figure 1) including transmission, clutch, air compressor and alternator, may be removed from the coach as a unit for repair to engine or related components. Follow the removal procedure in order.

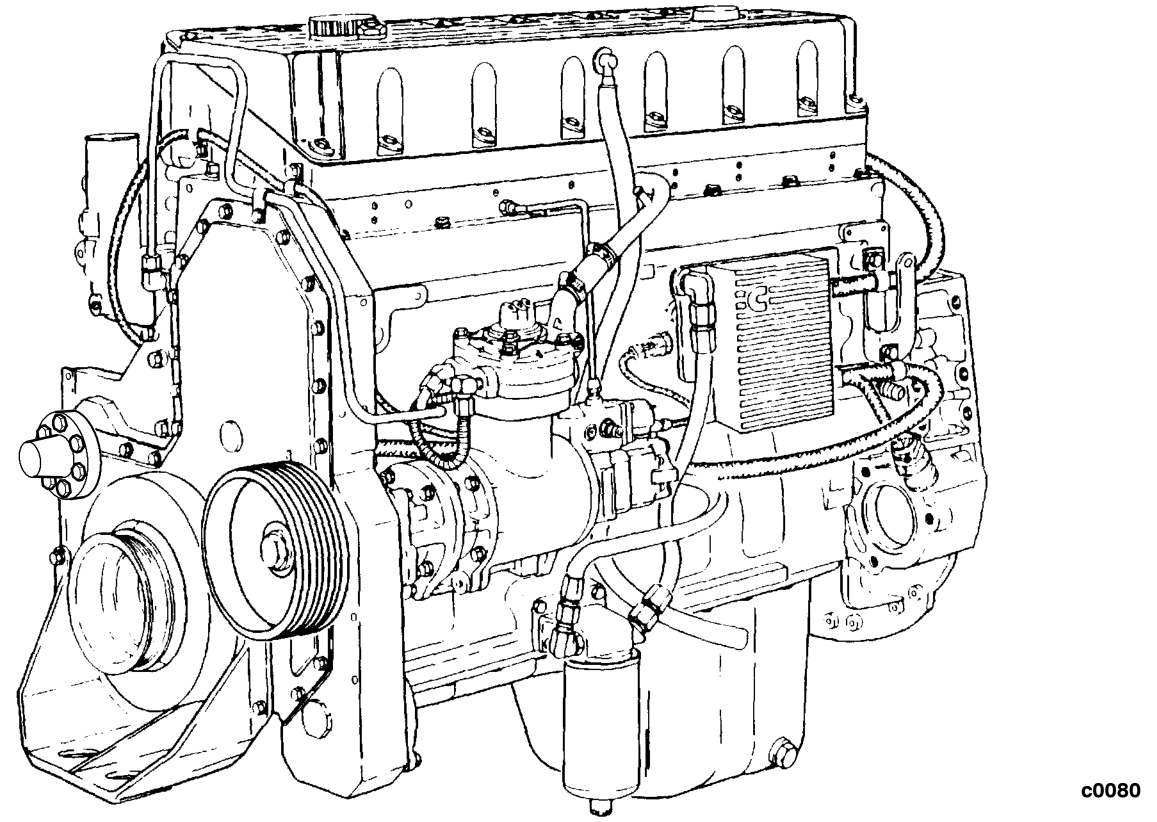


Figure 1. Power Module

NOTE: To facilitate removal and replacement of the engine module, and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly/engine stand is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of engine dolly P/N's 20-368 (Figure 5).

1. After coach is positioned on a twin-rail hoist of capacity, place blocks between axle bumpers and bumper stops to stabilize axle during bellows deflation.
2. Turn main battery switch to "OFF".
3. Disconnect height control valve links and pull down to vent air from rear suspension bellows.
4. Disconnect the drive shaft as outlined in Section 14 of this manual.
5. Drain the engine cooling system as directed in Section 6 of this manual.
6. Remove the cooling fan drive belts.
7. Remove the air conditioning compressor drive belts.
8. Open drain cock on the ping tank, and vent air from the wet tank.
9. Disconnect discharge air line from air compressor.
10. Disconnect compressor governor air lines from air/fuel junction block.
11. Disconnect fuel supply and return lines at air/fuel junction block.
12. Disconnect exhaust and air cleaner pipe clamps from turbocharger housing.
13. Disconnect exhaust muffler slip joint and remove exhaust pipe section.
14. Disconnect and remove air cleaner pipe section from turbocharger housing's inlet
15. Disconnect and remove the charge air inlet pipe from the turbocharger housing's outlet.
16. Disconnect and remove the charge air outlet pipe from intake manifold.
17. Disconnect Webasto heater's exhaust pipe from engine craddle.
18. Disconnect and remove Webasto heater's water inlet pipe section from engine oil cooler fitting.
19. Disconnect and remove the return water pipe section from engine water pump fitting.
20. Disconnect and remove water pump inlet pipe section from radiator assembly.
21. Disconnect and remove thermostat outlet pipe section from radiator assembly.
22. Disconnect and remove make-up water pipe from surge tank to water pump.
23. Disconnect ground cable.
24. Disconnect starter cable.
25. Disconnect alternator wiring and mark.
26. Disconnect all input or output coach wiring harnesses of the CELECT™ system's ECM and mark, including the main CELECT™ harness at ECM.
27. Disconnect the ATEC system's main coach harness at transmission.
28. Disconnect all coach water temperature guage and switch wire harnesses on thermostat housing.
29. Disconnect Transmission shift cable (HT-740 Trans).
30. Disconnect transmission shift linkage (Standard Trans).
31. Disconnect clutch cable (Standard Trans).
32. Remove the rear bumper.
33. Raise the coach approximately 4-6 inches (101.6-152.4 mm) above floor.
34. Remove the clamp bolts securing the engine sub-frame (cradle) to the coach body.
35. Position the dolly under the engine cradle.
36. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

⚠ **CAUTION** ⚠

Due to the minimum clearance between the engine's accessories and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be 1/8 to 1/4 inch (3.1-6.3 mm).

37. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach.

ENGINE MODULE INSTALLATION

1. To reinstall, reverse the above procedure.
2. Refill cooling system.
3. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil.
4. Remove vent plugs and pour fuel oil into filter body until filters are full.
5. Start engine and check operation.
6. Check fuel and cooling system connections for leakage.
7. Test operation of engine controls and accessories.

DIESEL ENGINE LUBRICATING OILS

Coaches equipped with a Series 60 engine have an oil capacity of 38 U.S. quarts (39.9 liters). Oil is added through the oil fill tube (Figure 2).

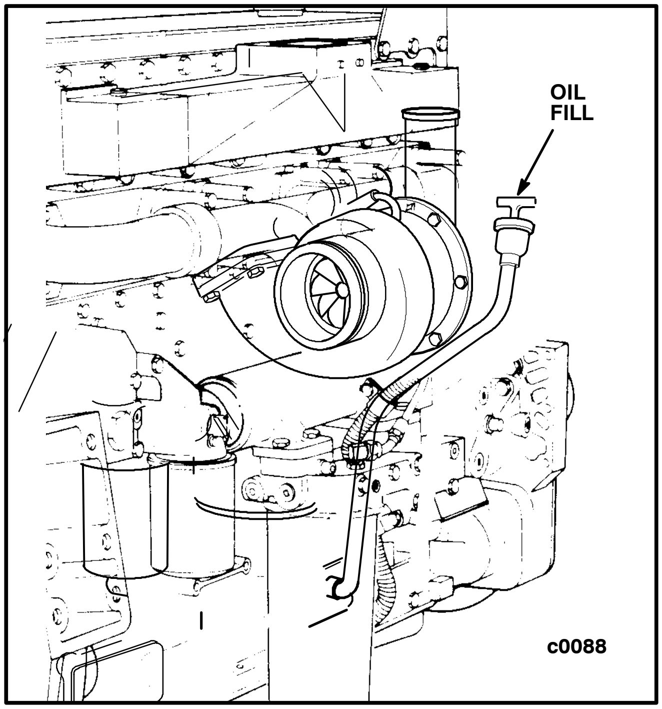


Figure 2. Oil Fill Tube

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. **The only lubricating oil recommended for Cummins M-11 diesel engines is the API Service Code CE or CF-4 - SAE 15W-40.**

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

SYNTHETIC OILS

Synthetic oils may be used in Cummins engines, provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils. Synthetic oils offer improved low temperature flow properties and high temperature oxidation resistance.

Product information about synthetic oils should be reviewed carefully. Performance additives often respond differently in synthetic oils. The use of synthetic oil does not permit extension of recommended oil drain intervals.

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term “oil supplier” is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation

API Service Code Classification	Military Specification	SAE Grade
CF-4		15W-40
CE		15W-40

SAE 15W-40 grade oil is recommended in the Cummins M-11 diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil.

NOTE: Monograde oils should not be used in these engines regardless of API Service Classification.

The Cummins M-11 engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limit

(ASTMD-874) shall not exceed 1.0% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 15W-40 with auxiliary heating. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction reducing compounds.

> **NOTE:** MCI warranty applicable to Cummins M-11 diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, the service intervals noted in the Cummins Operation and Maintenance Manual are minimum requirements to keep the engine warrant valid. Engine conditions may vary depending on the service environments from one coach to another, therefore, maintenance schedules should be formulated with the specific coach's service conditions in mind.

A suggested preventive maintenance practice includes a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Your oil supplier knows the physical properties of his products and maintains laboratories that can determine practical oil drain intervals. Request a check of oil samples and a report of there results for each engine's service conditions if different.

ENGINE MOUNTS

The engine is mounted to the engine cradle with four sets of beveled Metalastik mounts, two rear mounts attached to strut on each side of the flywheel housing (Figure 3) and two front mounts attached to the plate brackets on each side of the crankshaft (Figure 4). The mounts should be inspected every 24 months or 60,000 to 96,000 miles, whichever comes first, and replaced if necessary using the following procedure.

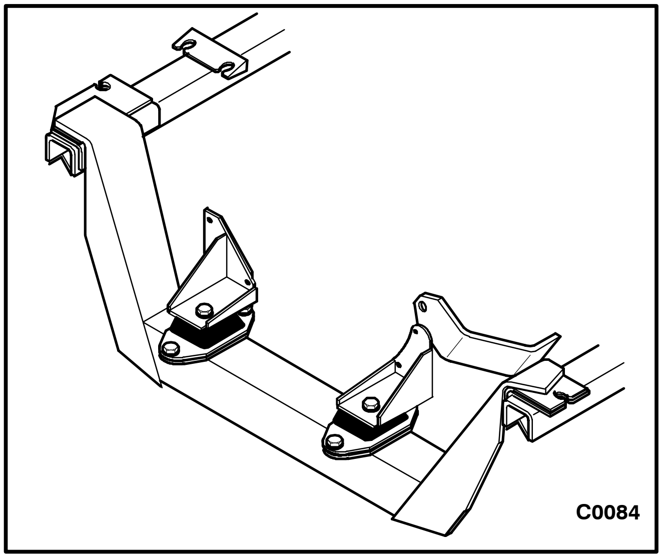


Figure 3. Rear Mount

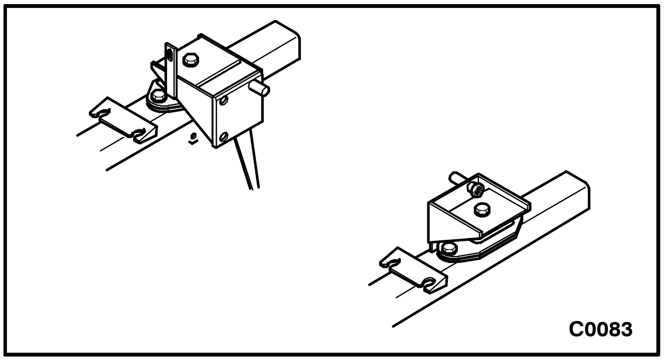


Figure 4. Front Mount

1. Unfasten and remove the damaged mount's center bolting, and loosen all other mount fasteners to allow its removal.
2. Position jack under engine and lift until bracket is clear and mount can be removed.
3. Position new mount under bracket, and slide center bolt through mount.

CAUTION

When replacing mount loosely tighten flange bolts to keep mount from moving on cradle while engine is being lowered.

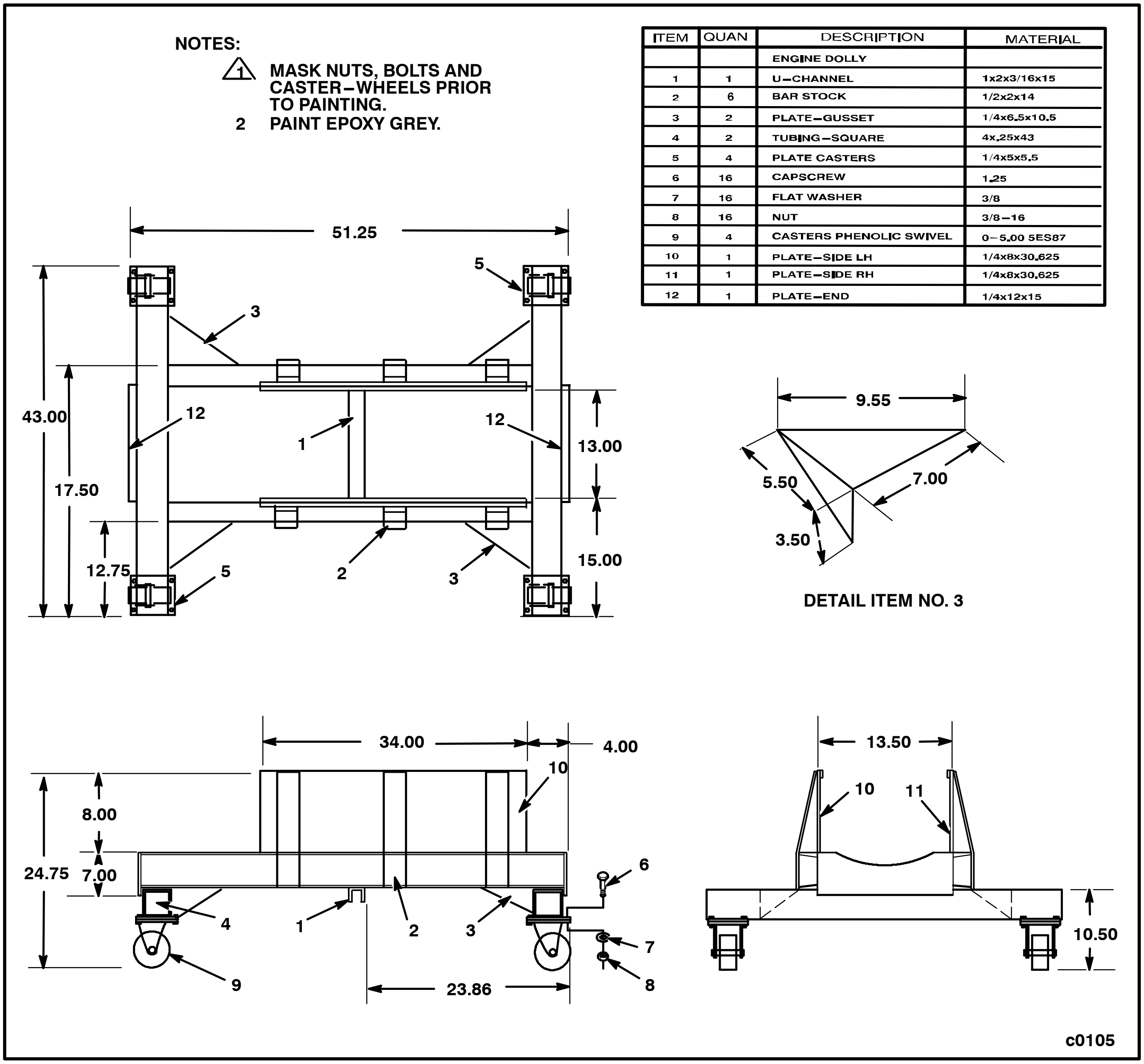
4. Gently lower engine down onto engine craddle to set mount correctly onto their brackets, and hand tighten with full weight of engine bearing on cradle assembly.

CAUTION

Improper installation of the motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.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NOTES:

1. MASK NUTS, BOLTS AND CASTER−WHEELS PRIOR TO PAINTING.
2. PAINT EPOXY GREY.

ITEM	QUAN	DESCRIPTION	MATERIAL
		ENGINE DOLLY	
1	1	U−CHANNEL	1x2x3/16x15
2	6	BAR STOCK	1/2x2x14
3	2	PLATE−GUSSET	1/4x6.5x10.5
4	2	TUBING−SQUARE	4x.25x43
5	4	PLATE CASTERS	1/4x5x5.5
6	16	CAPSCREW	1.25
7	16	FLAT WASHER	3/8
8	16	NUT	3/8−16
9	4	CASTERS PHENOLIC SWIVEL	0−5.00 5ES87
10	1	PLATE−SIDE LH	1/4x8x30.625
11	1	PLATE−SIDE RH	1/4x8x30.625
12	1	PLATE−END	1/4x12x15

Figure 5. Engine Dolly (P/N 20-368)

MISCELLANEOUS ENGINE TORQUE VALUES

FOR COMPLETE ENGINE SPECIFICATIONS REFER TO THE APPROPRIATE CUMMINS ENGINE SERVICE MANUAL.

Front Motor Mount Center Bolts (Rear of Coach)	75-80 ft-lbs (100-110 N·m)
Rear Motor Mount Center Bolts (Near Transmission)	110-125 ft-lbs (150-170 N·m)
Rear Motor Mount Strut-to Engine Locknuts	155 ft-lbs (210 N·m)
Crankshaft Vibration Damper Bolts	150 ft-lbs (203 N·m)
Crankshaft Pulley Bolts	50 ft-lbs (67 N·m)
Oil Drain Plug	65 ft-lbs (88 N·m)
Alternator Drive Pulley Bolt	400 ft-lbs (542 N·m)
Alternator Pulley Nut	210 ft-lbs (284 N·m)
Alternator Mounting Bracket Bolts	70 ft-lbs (94 N·m)
Starter Mounting Bolts	130 ft-lbs (176 N·m)
Air Compressor Housing-to-Gear Case Bolts	35 ft-lbs (47 N·m)
Air Compressor to Housing Bolts	50 ft-lbs (67 N·m)
Steering Pump Adapter-to-Gear Case Bolts	35 ft-lbs (47 N·m)
Steering Pump-to-Adapter Bolts	20 ft-lbs (27 N·m)

SPECIFICATIONS

OIL FILTER ASSEMBLY

Part Number	3318853 (Cummins)
Part Number	LF3000 (Fleetgard)
Design	Spin-On Full-Flow
Location	(Filter Head Mounted) LH Side of Coach

FUEL FILTER ASSEMBLY (PRIMARY)

Part Number	3315843 (Cummins)
Part Number	FS1212 (Fleetgard)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

WATER CHARGE FILTER ASSEMBLY

Part Number	WF2072 (Fleetgard)
Design	Spin-On
Location	(Filter Head Mounted) LH Side of Coach

SECTION 8A4

ENGINE INSTALLATION (CATERPILLAR 3176B & C-10)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	8A4-1
Maintenance	8A4-2
Service Tools	8A4-7
Miscellaneous Engine Torque Values	8A4-8
Specifications	8A4-8

GENERAL DESCRIPTION

The Caterpillar 3176B is a four-stroke cycle, right hand rotation, high speed high torque (325 or 350 HP) engine. These engines utilize a turbo-charged air intake manifold for optimum engine aspiration, and Caterpillar's electronic control system for efficient operation.

The Caterpillar 3176B utilizes an in-line cast iron block, together with a cast iron head containing a single overhead camshaft. The camshaft actuates the two inlet and exhaust valve rocker assemblies, and the one fuel injector rocker per cylinder. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshaft, power steering pump, water pump, air compressor drive and alternator accessory drive. The fuel pump is rear gear-case driven.

Each engine module is equipped with an oil cooler, one fuel filter assembly, a starting motor, air compressor, water pump, charge water filter, turbocharger and the electronic engine control system. Additionally, the engine is fitted with a single combination full-flow/by-pass oil filter and oil cooler assembly.

Full pressure lubrication is supplied to all main, connecting rod bearings and other moving parts within the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the oil filter, from the filter, a small portion is delivered to the turbocharger by an external oil line. The remainder of the filtered oil is delivered to the oil cooler, or bypasses the cooler, and enters the block's oil gallery. This gallery feeds oil to the cylinder head's camshaft bearings and rocker assemblies, and the remainder lubricates the main and connecting rod bearings.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the rear gear-case driven fuel pump, and then through the electronic engine control system's ECM, through the fuel filter and into the fuel supply and return manifold. It is then forced into the fuel inlet in the cylinder heads and finally to the injectors. Excess fuel from the injectors is returned to the fuel tank via the manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine's exhaust gas. The air then flows through the Charge-Air-Cooler in the radiator assembly, where it is cooled and returned to the intake manifold. The cooled air charge is then introduced into each cylinders with the engine's intake strokes.

Some general specifications of this engine are shown in the following chart.

Engine Specifications
Caterpillar 3176B

Type	4 cycle
Number of Cylinders	6
Bore (inches)	4.922
Bore (mm)	125
Stroke (inches)	5.5
Stroke (mm)	140
Comp. Ratio	16:1
Total Displacement (inches)	628
Total Displacement (mm)	10.3
Number of Main Bearings	7
Rated Full Load Speed (RPM)	2100

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual. Refer to Sections 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication).

MCI Parts Books, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as "Left-Hand", "Right-Hand", "Front" or "Rear" when viewing the engine from the flywheel end. This is opposite to the position of these parts with respect to a coach installation. All parts of the coach are designated "Left-Hand", "Right-Hand", "Front" or "Rear" in relation to the normal position of the driver facing forward. Engine manufacturer's designations have been retained to eliminate potential problems in engine parts identifications and locations.

MAINTENANCE

ENGINE MODULE REMOVAL

The power module (Figure 1) including transmission, clutch, air compressor and alternator, may be removed from the coach as a unit for repair to engine or related components. Follow the removal procedure in order.

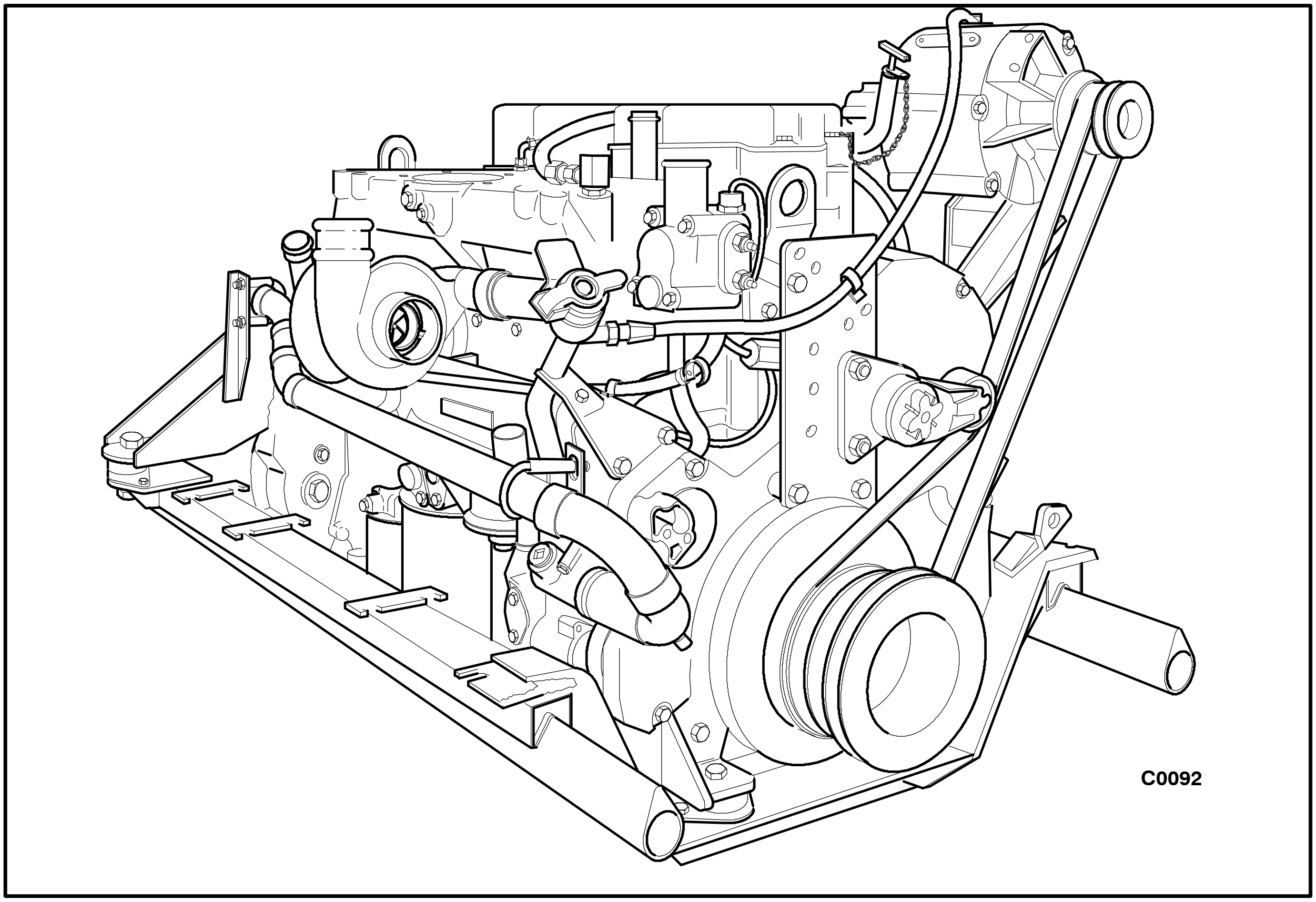

Figure 1. Power Module

NOTE: To facilitate removal and replacement of the engine module, and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly/engine stand is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of engine dolly P/N's 20-377 (Figure 5).

1. After coach is positioned on a twin-rail hoist of capacity, place blocks between axle bumpers and bumper stops to stabilize axle during bellows deflation.
2. Turn main battery switch to "OFF".
3. Disconnect height control valve links and pull down to vent air from rear suspension bellows.
4. Disconnect the drive shaft as outlined in Section 14 of this manual.
5. Drain the engine cooling system as directed in Section 6 of this manual.
6. Remove the cooling fan drive belts.
7. Remove the air conditioning compressor drive belts.
8. Open drain cock on the ping tank, and vent air from the wet tank.
9. Disconnect discharge air line from air compressor.
10. Disconnect compressor governor air lines from air/fuel junction block.
11. Disconnect fuel supply and return lines at air/fuel junction block.
12. Disconnect exhaust and air cleaner pipe clamps from turbocharger housing.
13. Disconnect exhaust muffler slip joint and remove exhaust pipe section.
14. Disconnect and remove air cleaner pipe section from turbocharger housing's inlet
15. Disconnect and remove the charge air inlet pipe from the turbocharger housing's outlet.
16. Disconnect and remove the charge air outlet pipe from intake manifold.
17. Disconnect Webasto heater's exhaust pipe from engine craddle.
18. Disconnect and remove Webasto heater's water inlet pipe section from engine oil cooler fitting.
19. Disconnect and remove the return water pipe section from engine water pump fitting.
20. Disconnect and remove water pump inlet pipe section from radiator assembly.
21. Disconnect and remove thermostat outlet pipe section from radiator assembly.
22. Disconnect and remove make-up water pipe from surge tank to water pump.
23. Disconnect ground cable.
24. Disconnect starter cable.
25. Disconnect alternator wiring and mark.
26. Disconnect all input or output coach wiring harnesses of the electronic engine control system's ECM and mark, including the main electronic control harness at ECM.
27. Disconnect the ATEC system's main coach harness at transmission.
28. Disconnect all coach water temperature guage and switch wire harnesses on thermostat housing.
29. Disconnect Transmission shift cable (HT-740 Trans).
30. Disconnect transmission shift linkage (Standard Trans).
31. Disconnect clutch cable (Standard Trans).
32. Remove the rear bumper.
33. Raise the coach approximately 4-6 inches (101.6-152.4 mm) above floor.
34. Remove the clamp bolts securing the engine sub-frame (cradle) to the coach body.
35. Position the dolly under the engine cradle.
36. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

⚠ **CAUTION** ⚠

Due to the minimum clearance between the engine accessories and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be 1/8 to 1/4 inch (3.1-6.3 mm).

37. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach.

ENGINE MODULE INSTALLATION

1. To reinstall, reverse the above procedure.
2. Refill cooling system.
3. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil.
4. Remove vent plugs and pour fuel oil into filter body until filters are full.
5. Start engine and check operation.
6. Check fuel and cooling system connections for leakage.
7. Test operation of engine controls and accessories.

DIESEL ENGINE LUBRICATING OILS

Coaches equipped with a Caterpillar 3176B engine have an oil capacity of 30 U.S. quarts (28 liters). Oil is added through the oil fill tube (Figure 2).

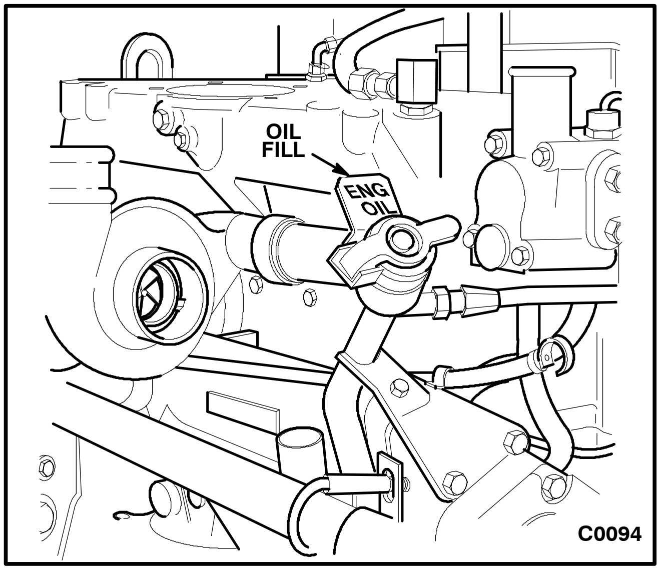

Figure 2. Oil Fill Tube

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. **The only lubricating oil recommended for Caterpillar 3176B diesel engines is the API Service Code CE or CF-4 - SAE 15W-40.**

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

SYNTHETIC OILS

Synthetic oils may be used in Caterpillar 3176B engines, provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils. Synthetic oils offer improved low temperature flow properties and high temperature oxidation resistance.

Product information about synthetic oils should be reviewed carefully. Performance additives often respond differently in synthetic oils. The use of synthetic oil does not permit extension of recommended oil drain intervals.

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term “oil supplier” is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation

API Service Code Classification	Military Specification	SAE Grade
CF-4		15W-40
CE		15W-40

SAE 15W-40 grade oil is recommended in the Caterpillar 3176B diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil.

NOTE: Monograde oils should not be used in these engines regardless of API Service Classification.

The Caterpillar 3176B engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limit (ASTMD-874) shall not exceed 1.0% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 15W-40 with auxiliary heating. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction reducing compounds.

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Generally, the service intervals noted in the Caterpillar Operation and Maintenance Manual are minimum requirements to keep the engine warrant valid. Engine conditions may vary depending on the service environments from one coach to another, therefore, maintenance schedules should be formulated with the specific coach's service conditions in mind.

A suggested preventive maintenance practice includes a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Your oil supplier knows the physical properties of his products and maintains laboratories that can determine practical oil drain intervals. Request a check of oil samples and a report of there results for each engine's service conditions if different.

ENGINE MOUNTS

The engine is mounted to the engine cradle with four sets of round molded rubber and steel mounts (isolators). The two rear mounts attached to strut mount bracket on each side of the flywheel housing (Figure 4) and two front mounts attached to the plate brackets on each side of the crankshaft (Figure 3). The mounts should be inspected every 24 months or 60,000 to 96,000 miles, whichever comes first, and replaced if necessary using the following procedure.

1. Unfasten and remove the damaged mount's center bolting, and loosen all other mount fasteners to allow its removal.

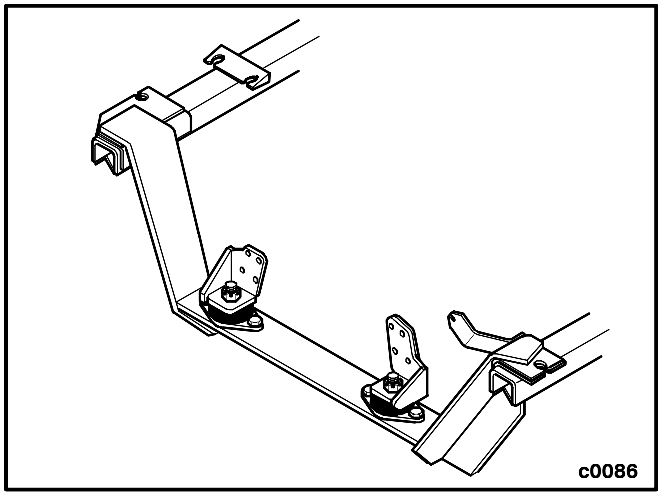


Figure 3. Front Mount

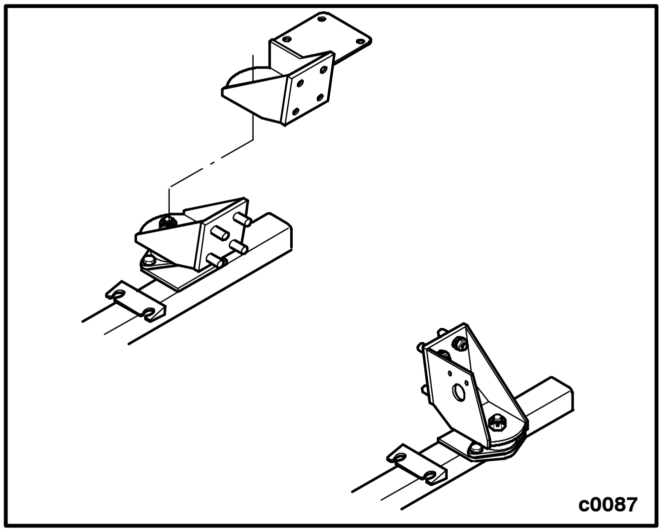


Figure 4. Rear Mount

2. Position jack under engine and lift until bracket is clear and mount can be removed.

3. Position new mount under bracket, and slide center bolt through mount.

⚠ CAUTION ⚠

When replacing mount loosely tighten flange bolts to keep mount from moving on cradle while engine is being lowered.

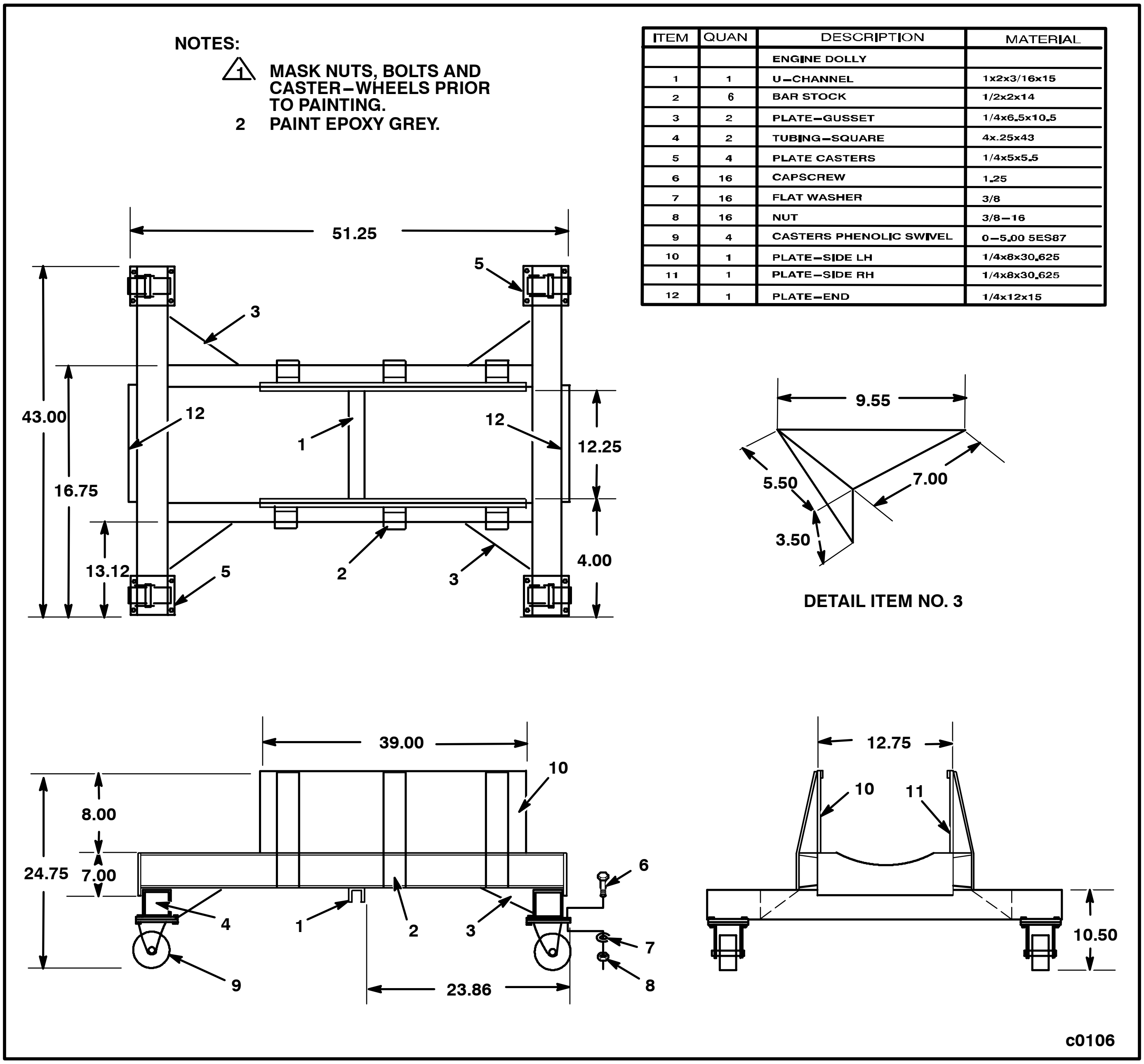
4. Gently lower engine down onto engine craddle to set mount correctly onto their brackets, and hand tighten with full weight of engine bearing on cradle assembly.

⚠ CAUTION ⚠

Improper installation of the motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.



NOTES:

1. MASK NUTS, BOLTS AND CASTER–WHEELS PRIOR TO PAINTING.
2. PAINT EPOXY GREY.

ITEM	QUAN	DESCRIPTION	MATERIAL
		ENGINE DOLLY	
1	1	U–CHANNEL	1x2x3/16x15
2	6	BAR STOCK	1/2x2x14
3	2	PLATE–GUSSET	1/4x6.5x10.5
4	2	TUBING–SQUARE	4x.25x43
5	4	PLATE CASTERS	1/4x5x5.5
6	16	CAPSCREW	1.25
7	16	FLAT WASHER	3/8
8	16	NUT	3/8–16
9	4	CASTERS PHENOLIC SWIVEL	0–5.00 5ES87
10	1	PLATE–SIDE LH	1/4x8x30.625
11	1	PLATE–SIDE RH	1/4x8x30.625
12	1	PLATE–END	1/4x12x15

51.25
43.00
16.75
13.12
12.25
4.00
9.55
5.50
7.00
3.50
DETAIL ITEM NO. 3
39.00
8.00
7.00
24.75
23.86
12.75
10.50
1
2
3
4
5
6
7
8
9
10
11
12
c0106

Figure 5. Engine Dolly (P/N 20-377)

MISCELLANEOUS ENGINE TORQUE VALUES

FOR COMPLETE ENGINE SPECIFICATIONS REFER TO THE APPROPRIATE CATERPILLAR ENGINE SERVICE MANUAL.

Front Motor Mount Center Bolts (Rear of Coach)	75-80 ft-lbs (100-110 N·m)
Rear Motor Mount center Bolts (Near Transmission)	110-125 ft-lbs (150-170 N·m)
Rear Motor Mount Strut-to Engine Locknuts	155 ft-lbs (210 N·m)
Crankshaft Vibration Damper & Pulley Bolts	220 ft-lbs (298 N·m)
Oil Drain Plug	50 ft-lbs (67 N·m)
Alternator Mounting Bracket Bolts	35 ft-lbs (47 N·m)
Starter Mounting Bolts	160 ft-lbs (217 N·m)
Air Compressor Housing-to-Gear Case Bolts	75 ft-lbs (101 N·m)
Adapter and Steering Pump-to-Gear Case Bolts	75 ft-lbs (101 N·m)

SPECIFICATIONS

OIL FILTER ASSEMBLY

Part Number	1R0716 (Caterpillar)
Design	Spin-On Full-Flow
Location	(Filter Head Mounted) LH Side of Coach

FUEL FILTER ASSEMBLY (PRIMARY)

Part Number	1R0712 (Caterpillar)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

WATER CHARGE FILTER ASSEMBLY

Part Number	1E6013 (Caterpillar)
Design	Spin-On
Location	(Filter Head Mounted) LH Side of Coach

SECTION 8B

COLD WEATHER STARTING

CONTENTS OF THIS SECTION

SUBJECT **PAGE**

Ether Start System 8B-1

K.B.I. Ether Start System 8B-1

Engine Heaters 8B-2

ETHER START SYSTEM

DESCRIPTION

The coach is equipped with a cold weather starting fluid cup (Figure 1) located on the top of the engine air intake. If the temperature is below 40°F (4.4°C), it may be necessary to use starting fluid capsules. Use one capsule at temperatures above 0°F (–15°C), or two at lower temperatures. **DO NOT USE MORE THAN TWO FLUID CAPSULES**. To use capsules, lift cover of starting fluid cup, insert capsule(s), force down over pointed tube in cup and squeeze until all fluid enters cup. Remove capsule(s) and start engine.

⚠ WARNING ⚠

Fire hazard - starting fluid used in the capsule is highly flammable, poisonous, and is anesthetic. DO NOT smoke while using or handling capsules, and keep away from flame or high temperatures. Avoid inhaling fumes produced by starting fluid.

K.B.I. ETHER START SYSTEM

An optional ether start system (see Figure 2) with a replaceable pressurized ether bottle can be provided. Ether is injected into the engine blower housing when the coach is in the start mode (main switch "ON") and the ether start switch on the driver's left-hand switch panel is depressed. Ether travels through a line from the ether solenoid valve to an atomizer which is installed in the engine blower housing. The valve and ether bottle are mounted to a bracket attached to the underside of the coach floor at a point to the left of the aisle service door which is just in front of the rear cross seat.

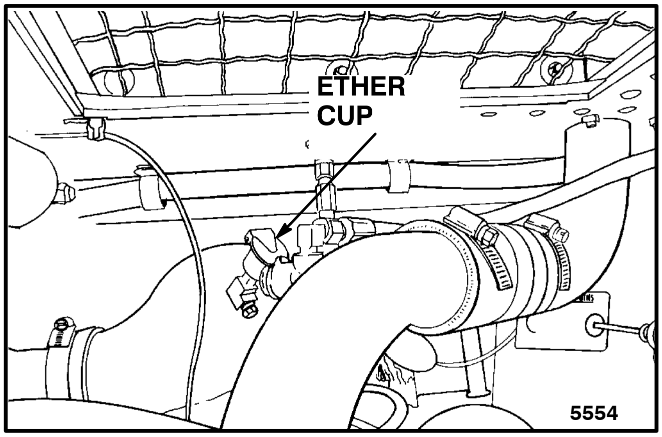


Figure 1. Ether Starting Fluid Cup on Air Intake

OPERATION

The coach must be in the start mode (main switch "ON") and the ether switch at the driver's lower left-hand switch panel must be depressed before the ether injection process will occur. The ether start switch is wired to the starting circuit via the oil pressure switch and becomes inoperative after the engine is running and oil pressure reaches 3 psi, preventing ether injection during normal engine operation. Additionally, the ether system thermostat, which is surface mounted at the water pump housing, must sense a maximum temperature of 40°F before the solenoid valve will open and allow ether to flow to the engine. Refer to the "Wiring Diagram Book" for the ether start system.

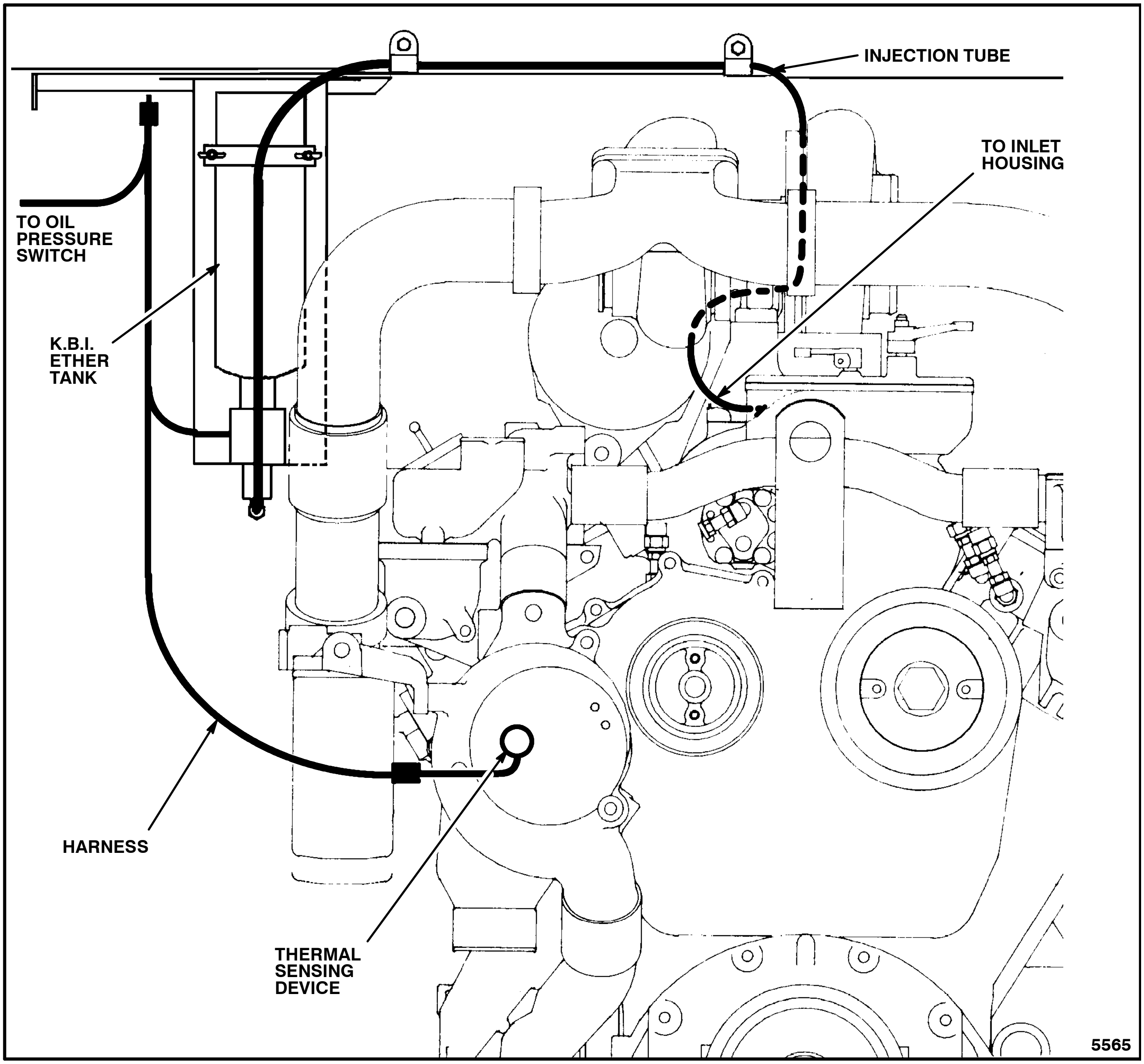

INJECTION TUBE
TO INLET HOUSING
TO OIL PRESSURE SWITCH
K.B.I. ETHER TANK
HARNESS
THERMAL SENSING DEVICE
5565

Figure 2. K.B.I. Ether Start Installation

ENGINE HEATERS

BLOCK AND OIL PAN HEATERS

An engine block heater is available. It is a 115-volt, 1500-watt, single loop element type, fitted in the block behind the crankcase dipstick.

An oil pan immersion heater is also available. It is a 115-volt, 200-watt single loop element type fitted in the side of the oil pan.

Both heaters are supplied with a $\frac{3}{16}$-inch HPN cord and plug set when ordered separately. When ordered together, or with the optional lavatory tank immersion heater, a junction box is supplied. This box is installed in an exterior access door at the rear of the coach.

These heaters are non-serviceable, except for the cords, and if faulty, must be replaced.

SECTION 8C

ELECTRONIC ENGINE CONTROL SYSTEMS

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	8C-1
Components	8C-1
Maintenance	8C-5

GENERAL DESCRIPTION

Generally speaking most diesel engine electronic control systems operate approximately in the same manner. The systems receive, process and store information from sensors located throughout the engine and other related components. Input from these and other devices determines the command signals issued to maintain the engine's proper environmental and economic operation.

The systems are responsible for the storage and retrieval of vital engine information, the processing of received data and the transmittal of command signals that will achieve correct engine functions relating to operation. The systems can be interconnected to other electrically or electronically controlled components such as transmissions and throttle devices. The following is a list of functions or tasks that a typical engine control system should address. Control of the engine's fuel injection function (i.e., timing of and fuel metering), including transient fuel control (smoke control). Communication with the transmission control system. Monitoring of rated speed and power, torque shaping, engine governing, cold start logics, engine oil, intake air and coolant temperatures.

The systems also have protection circuits that reduce power and eventually shut down the engine completely in the event of a potentially damaging engine condition, such as low oil pressure, low coolant level or high engine temperature. The systems should incorporate a self-diagnostic feature, and may identify a fault condition or potential problem by illuminating a telltale light and/or an audible alarms. Fault codes identifying failed components are logged into the system's ECM memory for later readout by maintenance personnel.

The specific systems that are covered by this sub-section are the Detroit Diesel DDEC™ II and III, Cummins CELECT™ and the Caterpillar electronic engine control systems. For convenience this write-up will reference DDEC II and III terminology where applicable to describe the components

NOTE: DDEC II vs DDEC III system functions are approximately the same. DDEC III allows for a more detailed logging/reporting feature and enhanced optional component monitoring. Additionally, the DDEC III system automatically controls clutch fan operations of the Charge Air-Cooling system.

COMPONENTS

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Module (ECM) is the microprocessor-controlled electronic monitoring and storage unit for an engine control system. The ECM unit mounts on the engine (Figure 1).

The ECM can identify problem conditions within the engine by comparing input from the various sensors to a set of parameters (calibration and design data) stored within the ECM. After processing the input the ECM sends high current command pulses to the injector solenoids to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder.

Heat generated by the ECM is dissipated via an internal heat exchange process. Fuel from the fuel tank flows through the body and absorbs heat from the unit before passing through the fuel filters and into the engine.

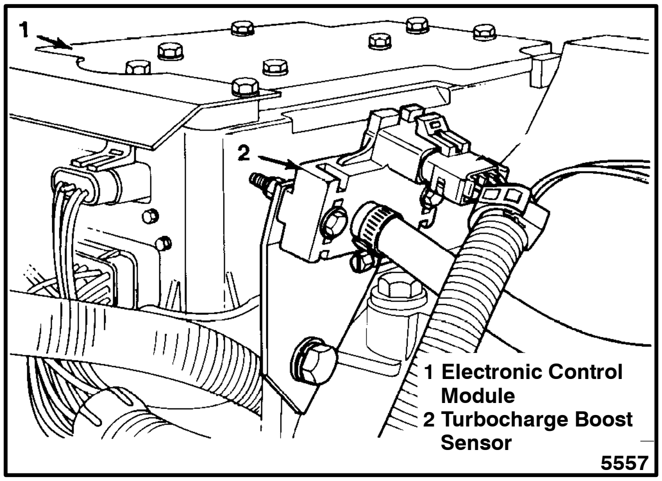


Figure 1. Electronic Control Module (8V-92)

NOTE: There are no user-serviceable parts within the ECM. If it is determined that the ECM is defective, it must be replaced in its entirety.

The ECM is factory programmed and is determined by a specific engine/transmission/tire size and axle ratio combination. Refer to the table later in this section for the factory ECM programming for particular combinations. Reprogramming will be required for any change within a combination. Information on such reprogramming follows that table.

VEHICLE INTERFACE MODULE (VIM)

Some transmission's links to the engine control system's ECM requires a Vehicle Interface Module (VIM). This interface enables engines and transmissions of different manufacture to communicate vehicle speed from a VSS and other related information. Refer to Serial Communication Interface (SCI) standards SAE J-1708 and J-1587. The VIM is typically located on the engine or in the A/C and DDEC/ATEC junction box.

VEHICLE SPEED SENSOR (VSS)

The Vehicle Speed Sensor (VSS) is located at the transmission output shaft and provides input to the ECM regarding vehicle speed.

ELECTRONIC UNIT INJECTORS (EUI)

The Electronic Unit Injectors (EUI) (Figure 2) are electronically controlled solenoid operated fuel injectors mounted into the cylinder head above each cylinder. The solenoid-operated poppet valve on each EUI performs injection timing and fuel metering functions.

Pressurization of fuel inside the injector occurs by a conventional cam-operated plunger. When the solenoid valve on the EUI is closed, fuel is pressurization and injection is initiated at beginning of injection (BOI) (Figure 3).

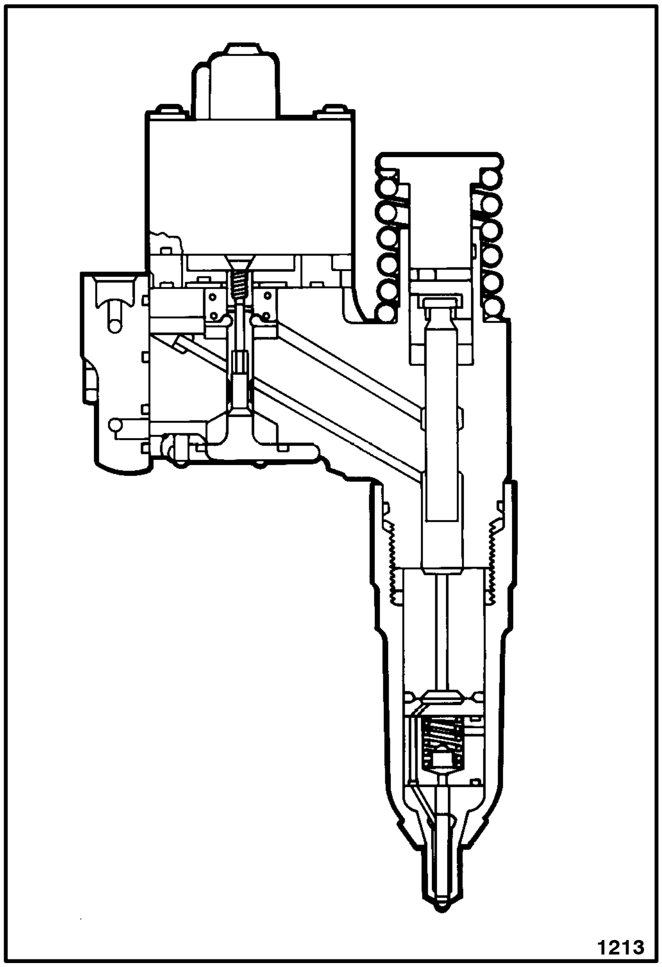


Figure 2. Electronic Unit Injector

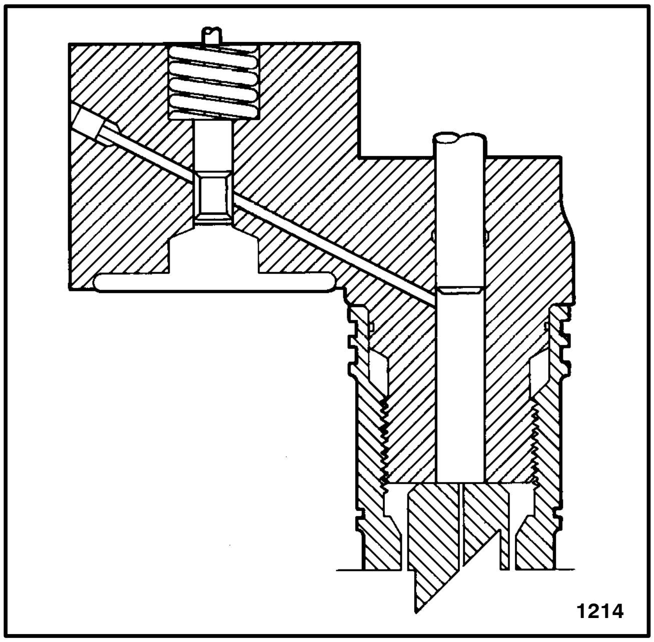


Figure 3. Solenoid Valve (Closed)

When the solenoid valve on the EUI is open pressure decreases and fuel injection ends (Figure 4). The duration of solenoid valve closure (pulse width) determines quantity of fuel injected.

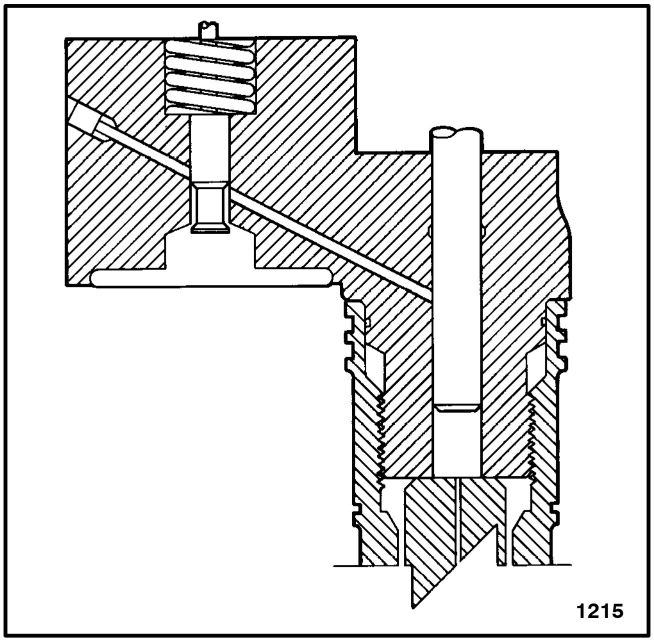


Figure 4. Solenoid Valve (Open)

TIMING REFERENCE SENSOR (TRS)

The Timing Reference Sensor (TRS) (Figure 5) is located behind the camshaft drive pulley at the engine block front end plate on 8V-92 installations. A pulse wheel on the camshaft drive pulley causes the sensor to send timing pulses to the ECM. The TRS is located below the accessary drive on the front gear case in Series 60 installations. The TRS provides one signal per cylinder at its proper firing position.

SYNCHRONOUS REFERENCE SENSOR (SRS)

The Synchronous Reference Sensor (SRS) (Figure 5) is also located behind the camshaft drive pulley at the engine block front end plate on 8V-92 installations. The SRS on the Series 60 installations can be found at the RH rear of the front gear case adjacent to the accessary drive. The SRS provides one signal per revolution of the engine crankshaft.

THROTTLE POSITION SENSOR (TPS)

The Throttle Position Sensor (TPS) (Figure 6) is located in the electronic foot pedal assembly (EFPA) and converts the throttle position into a signal usable by the ECM. This sensor, in effect, replaces the mechanical linkage from the accelerator treadle to the engine.

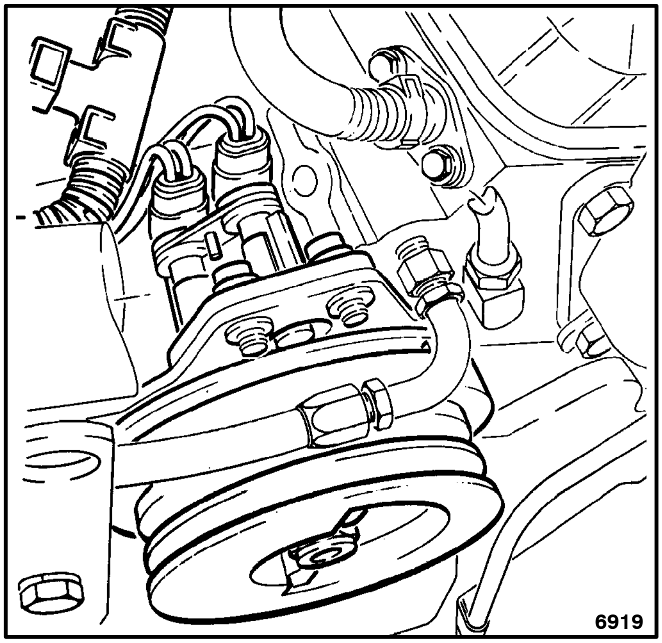


Figure 5. Timing & Synchronous Reference Sensors (8V-92)

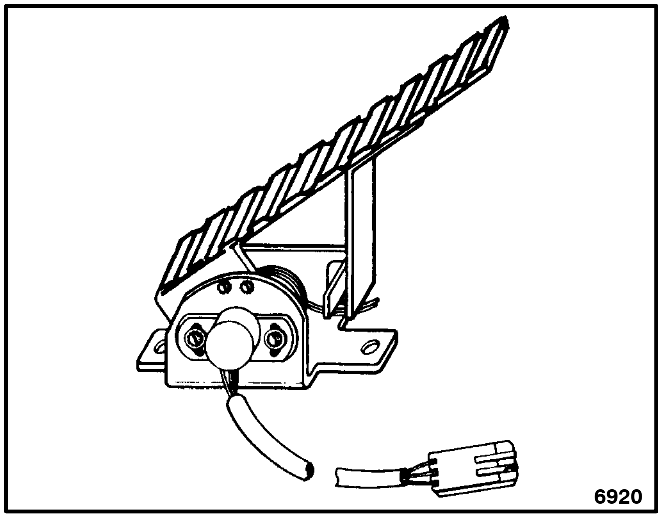


Figure 6. Throttle Position Sensor

TURBOCHARGED BOOST SENSOR (TBS)

The Turbocharged Boost Sensor (TPS) (Figure 1) is located between the turbocharger discharge and the blower, and monitors turbocharger compressor discharge pressure. The TBS provides a signal to the ECM during engine operation for transient smoke control.

OIL PRESSURE SENSOR (OPS)

The Oil Pressure Sensor (OPS) (Figure 7) located in the engine oil gallery at the front side of the block on 8V-92 installations, and at the rear RH side of block above the OTS for Series 60 installations. The OPS monitors oil pressure in the engine and, if engine oil pressure falls below a specified minimum value the ECM should alert the driver by illuminating the amber "CHECK ENGINE" light and/or the red "STOP ENGINE" light. The (ECM) will sound an audible alarm and initiate the engine protection sequence and shut-down procedure.

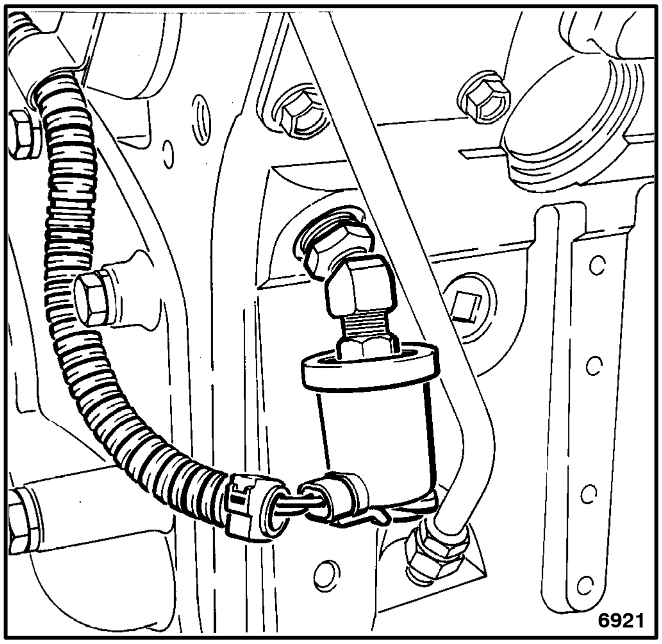


Figure 7. Oil Pressure Sensor (8V-92)

OIL TEMPERATURE SENSOR (OTS)

The Oil Temperature Sensor (OTS) (Figure 8) is located in the engine oil gallery at rear RH side of block below the OPS for Series 60 DDEC III installations.

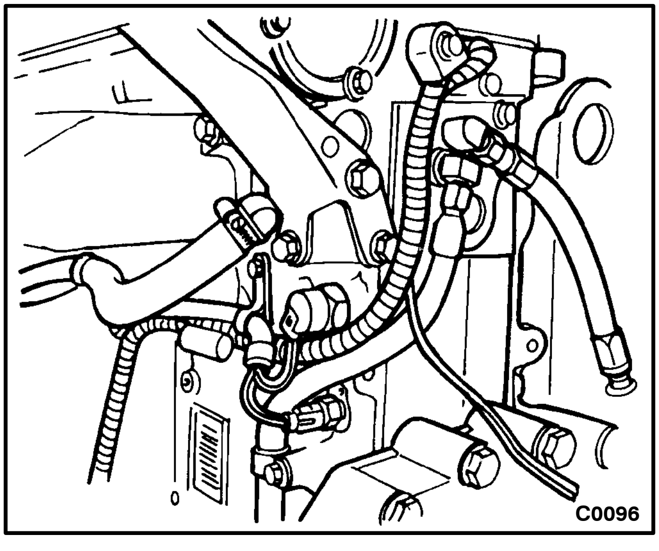


Figure 8. Oil Temperature Sensor (Series 60)

COOLANT TEMPERATURE SENSOR (CTS)

The Coolant Temperature Sensor (CTS) monitors engine coolant temperature, and is mounted in the engine thermostat housing (Figure 9). Additionally, the CTS input may be used in the cold start logic feature of some electronic control systems ECM.

If the coolant temperature exceeds the specified maximum the (ECM) will illuminate the amber "CHECK ENGINE" telltale warning light. If the coolant temperature exceeds the (ECU) shut-down parameters the red "STOP ENGINE" telltale warning light will illuminate. The ECM will initiate the engine protection sequence, and begin engine shut-down procedures.

NOTE: For more information on the engine protection sequence see "Diagnostic" later in this sub-section.

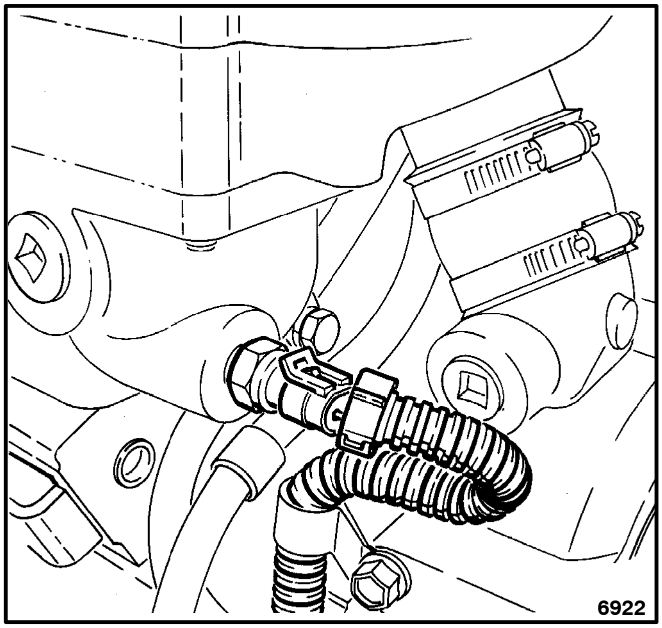


Figure 9. Coolant Temperature Sensor (8V-92)

COOLANT LEVEL SENSOR (CLS)

The Coolant Level Sensor (CLS) is a two piece assembly. The assembly is made up of a sensor probe and module. The CLS probe and module assembly sends a constant signal to the ECM to indicate coolant level in the engine's cooling system.

The vehicle manufacturer supplied CLS probe is located near the bottom of the radiator's surge tank, and monitors the coolant level (Figure 10).

The CLS module is located in the A/C DDEC/ATEC junction box (Figure 11). The module links the probe to the ECM. If coolant level drops the ECM will illuminate the telltale warning and initiate the engine shut-down procedure.

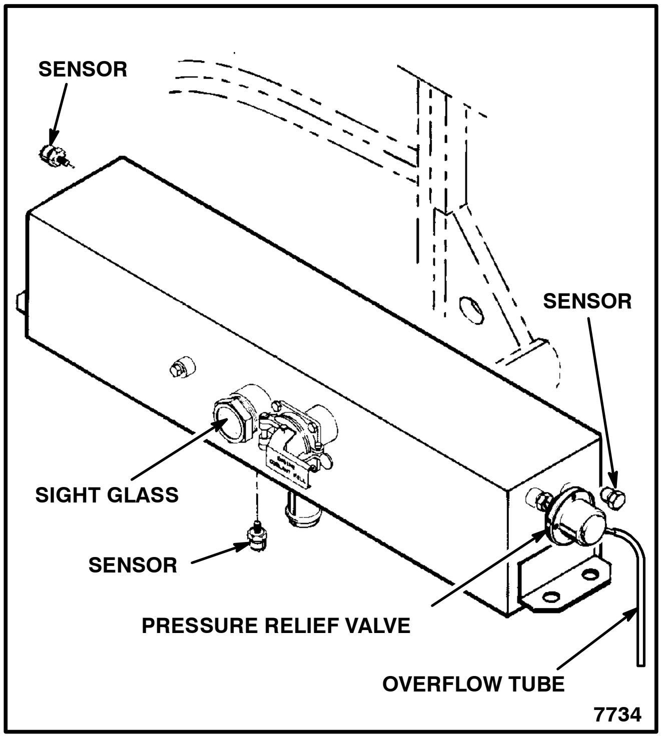


Figure 10. Coolant Level Sensor

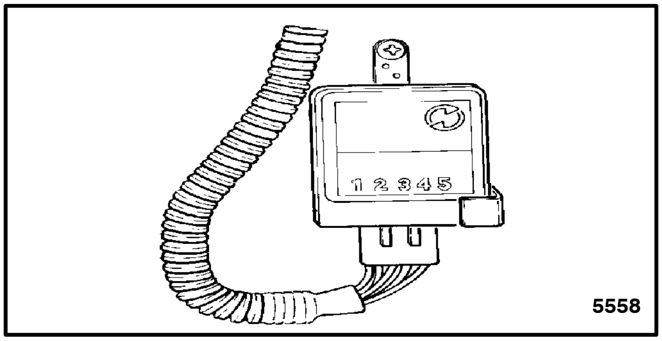


Figure 11. Coolant Level Sensor Module

AIR TEMPERATURE SENSOR (ATS)

The Air Temperature Sensor (ATS) monitors intake manifold air temperature to attain input for charge-air clutch fan control (Figure 12). Additionally, the ATS input may be used in the cold start logic feature of some electronic control systems (ECM).

MAINTENANCE

DIAGNOSTICS

DDEC II and III electronic engine control system's diagnostics feature can be separated into three areas: Engine Performance Diagnostics, Self Diagnostics and Engine System Protection.

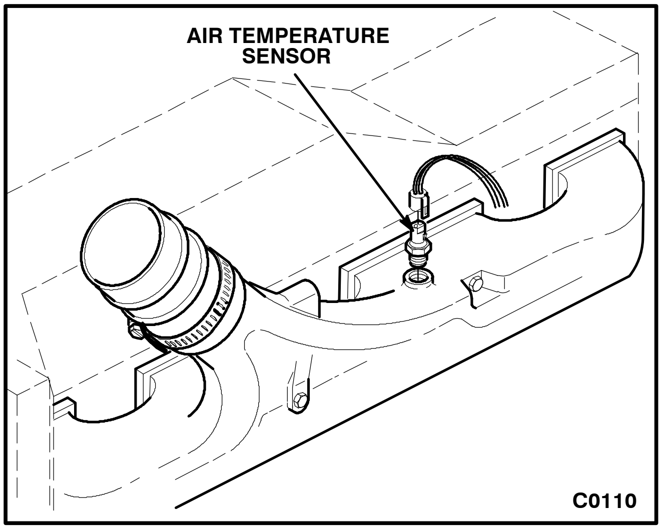


Figure 12. Air Temperature Sensor (Series 60)

Engine Performance Diagnostics

The DDEC II and III systems continuously monitors various sensors and makes adjustments to injector timing and fuel quantity input, depending on EEPROM programming and sensor input, to provide optimum performance and minimal acceleration smoke under all operating conditions. Cold weather starting is improved by matching the fuel input and timing to the ambient air temperature.

System Self-diagnostics

The system continuously monitors itself and all related wiring for faults. If a fault is detected, the "CHECK ENGINE" and/or "STOP ENGINE" light(s) will illuminate (depending on the severity of the fault), and if the fault is in the main microprocessor, a backup microprocessor takes control.

When the system is under the control of the backup microprocessor the engine will continue to function normally. However, fuel injector control logic is based on the following sensor input information:

1. Throttle Position Sensor (TPS).
2. Vehicle Speed Sensor (VSS).
3. Turbocharger Boost Sensor (TBS).
4. Coolant Temperature Sensor (CTS).

All other sensor input is ignored and a generic set of calibration data is substituted which may degrade engine performance while in the backup mode. Auxiliary features which remain operational during backup mode are the engine protection feature and accessary equipment pulse width modulation.

Engine Protection (With Shutdown Sequence)

When the engine protection feature is initiated the amber "CHECK ENGINE" and red "STOP ENGINE" telltale warning lights on the left hand telltale cluster are illuminated (Figure 13). A fault code is logged into the ECM's memory and the following power reduction sequence is begun.

A. Five seconds after fault detection power is reduced to 84% of current throttle.

B. Ten seconds after fault detection power is reduced to 68% of current throttle.

C. Fifteen seconds after fault detection power is reduced to 53%of current throttle.

D. Seventeen seconds after fault detection power is reduced to 40% of current throttle. No further reduction of power occurs past 40% throttle.

NOTE: This should give the driver enough power to move the coach to a point of safety where it can be shut down.

E. After thirty seconds all fuel is cut off completely.

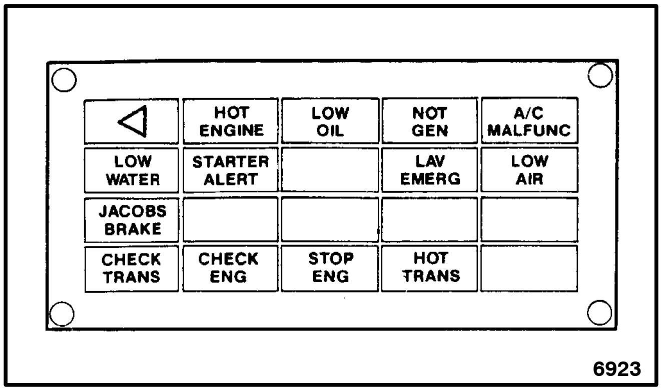


Figure 13. Telltale Panel

The engine overrule switch is provided on the driver's upper left-hand switch panel (Figure 14). The switch will allow an additional thirty seconds of fuel before shutdown occurs. The overrule switch is designed so that it CANNOT be held "ON" to continuously overrule shutdown.

If the engine protection feature is triggered, it will remain active until the fault goes away or the system is reset. The DDEC II and III systems can be reset by parking the bus, shutting off the ignition, waiting ten seconds and then restarting the engine.

If the fault was temporary, the indicator lights on the telltale panel will go out and normal operation will resume. A fault code will be logged in memory until the memory is cleared. The memory may be cleared by use of a DDR (Figure 16). The fault may also be cleared by restarting the engine ten times without the fault being relogged.

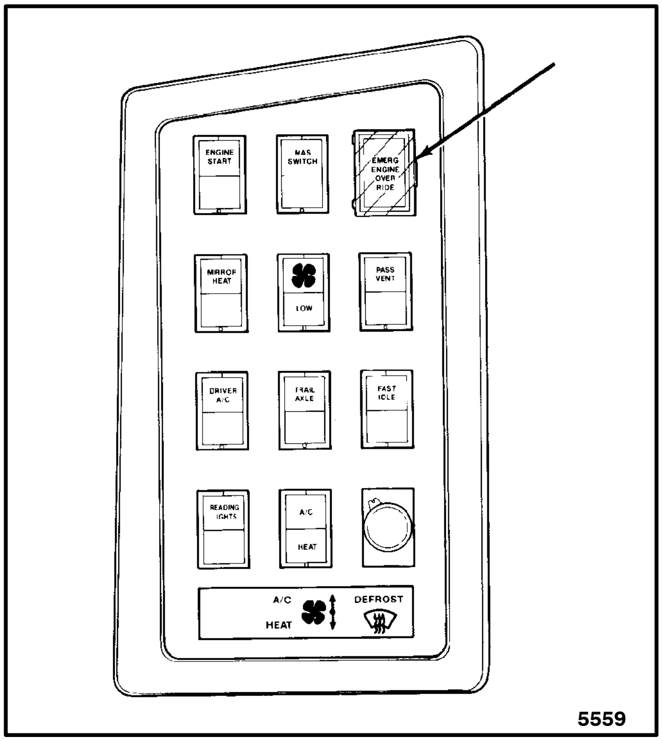


Figure 14. Stop Engine Override Switch

If the fault remains after the engine is restarted, the problem is not temporary, and maintenance or repair of the problem is indicated.

Coolant Overtemperature Protection

Detroit Diesel began adding the coolant overtemperature protection (COP) effective on 8V-92 engines with engine serial number 08VF 140229.

The COP feature protects the engine from excessive coolant overtemperature conditions by automatically reducing engine power when the coolant temperature exceeds 212.5°F (100.3°C). The amount of power reduction depends on the position of the TPS at the time of condition, and how much the coolant temperature increases above 212.5°F (100.3°C) see power reduction chart (Figure 15).

If the cause of the overtemperature is temporary, such as climbing a severe grade, the amount of available power will be increased as the temperature decreases, with 100% power available as soon as the temperature drops to 212.5°F (100.3°C).

If a severe cooling system problem exists, such as a broken fan belt, and temperature continues to increase in spite of the power reduction, the stop engine light (SEL) will be activated at 222F (105.5C). To assure that adequate power is available to move the coach under emergency conditions, the COP feature will not reduce the amount of available throttle to less than 50%. If the engine overheating continues, programmed engine shutdown will occur.

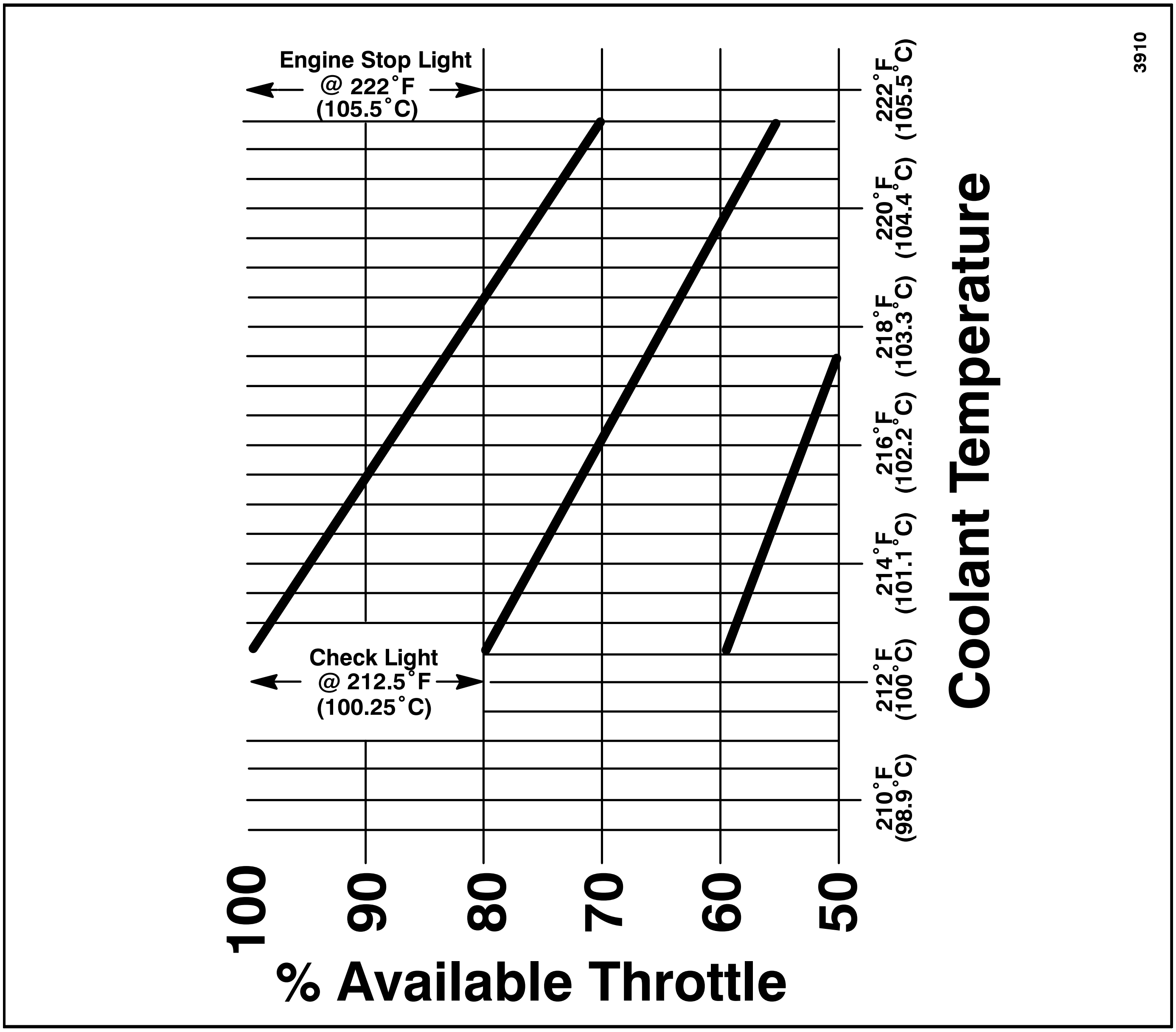


Figure 15. Coolant Overtemperture Power Reduction Chart

NOTE: The coolant overtemperature protection feature can be added to a coach with a DDEC II engine with a serial number prior to 08VF 140229 (8V-92) under the following circumstances.

A. If the coach does not have cruise control, the power down prom can be added to the existing ECM, and the ECM reprogrammed.

B. If the coach does have cruise control, the ECM must be replaced.

TROUBLESHOOTING

The replacement of any internal engine components should be based on diagnostic codes indicating faulty components. Refer to the applicable system's troubleshooting manual and/or the appropriate instruction manual for the diagnostic data reader being used for complete information on diagnosis of components.

Troubleshooting the DDEC II or III systems can be divided into the following two areas. The first being mechanical checks such as wiring and connector problems. The second being the proper use of the DDR, and the interpreting of the logged codes.

Mechanical Checks

Mechanical checks involve checking all wiring and connectors for proper connection, dirty or corroded terminals and visual inspection of components for loose, damaged, or missing parts.

All wiring is Teflon coated with crimp-type connectors. Solder-type connectors are not used nor recommended on wiring because normal vibration will cause the solder connection to fail in time.

Diagnostic Data Reader

The Diagnostic Data Reader (DDR) is a hand-held electronic device that can be connected to either of the two DDL's for accessing and review of logged fault codes (Figure 16).

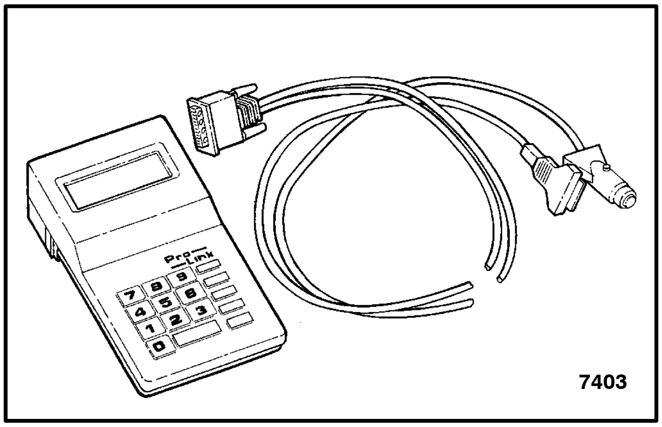


Figure 16. Diagnostic Data Reader

The Diagnostic Data Link (DDL) connectors are installed on the coach and enable the user to connect a DDR to access and interpret the fault codes logged into the ECM's memory and /or operational data (Figure 17).

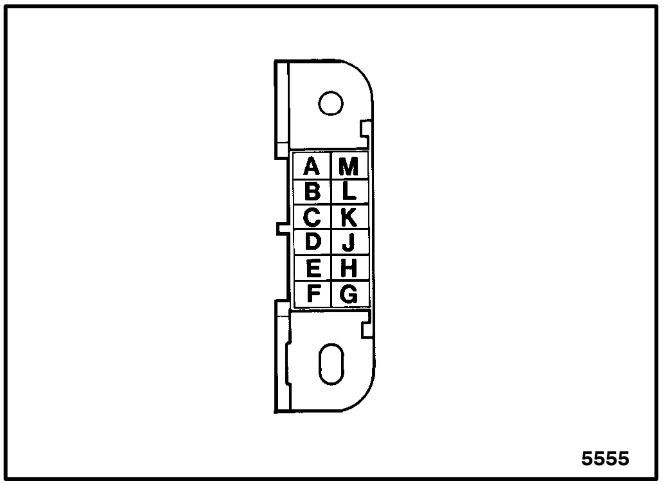


Figure 17. Diagnostic Data Link Connector and Test Switch

One of the two DDL connectors are located in the A/C DDEC/ATEC junction box. The other connector is located in a floor-mounted box near the driver's modesty panel in DDEC II installations, and under the dashboard near the steering column on DDEC III installations..

The DDR should be able to electronically troubleshoot all DDEC II and III system components and related wiring. Operation of the DDR should be in accordance with the "Diagnostic Data Reader User's Manual". Refer to the instruction book provided for complete diagnostic procedures.

If a DDR is not immediately available, the fault codes logged in the ECM's memory can be interpreted by use of the "CHECK ENGINE" switch on the upper front of the DDEC control panel in the A/C DDEC/ATEC junction box, or the diagnostic switch on the LH switch panel. Turn the switch on and note the flashing light on the telltale panel. The light should flash a sequence of codes which identify the faulty component or system. For example, if the light flashes once, then pauses and flashes three more times, this would indicate a fault code 13, which is interpreted as a problem with the coolant level sensor.

Refer to the DDEC II or III Troubleshooting Guide for a complete listing of the fault codes and their meanings.

NOTE: Read the "WELDING CAUTION" in this books introduction before beginning any welding procedures on coaches equipped with an electronic engine control system.

ECM Reprogramming

The following tables list some of the 8V-92 engine models with electronic engine controls and there transmission/axle ratio/tire sizes and combination for which the system's ECM was programmed. Changes in transmission and axle ratio will require that the ECM be reprogrammed. A change in tire size which results in tire revolutions per mile being less than 485 rpm or more than 491 rpm, may also require reprogramming the ECM. In all but one combination (see table) the standard MCI supplied tires range in rpm from these two values and the ECM is programmed by Detroit Diesel for 488 rpm which is the average of those values. This slight deviation from the actual tire rpm results in a maximum error of 0.6% or 0.4 mph at 65 mph.

Computing the proper pulse to be used when reprogramming an ECM is done by using the similar information as the following reference tables and formula.

MCI Engine Part Number	Engine	Transmission	Top Gear Ratio	Sensor Pulses Per Revolution	Axle Ratio	Tires Revolutions Per Mile	Pulses Per Mile
8L-1-44	8V-92TA	Hydraulic	1.0	14	3.23:1	488	22,067
8L-1-52	8V-92TA	Manual	1.0	14	3.33:1	488	22,750
8L-1-53	8V-92TA	Hydraulic	1.0	14	3.33:1	488	22,750
8L-1-54	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000
8L-1-55	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000
8L-1-178	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000
8L-1-179	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000

FEDERAL/CANADIAN DDEC II ENGINES

MCI Engine Part Number	Engine	Transmission	Top Gear Ratio	Sensor Pulses Per Revolution	Axle Ratio	Tires Revolutions Per Mile	Pulses Per Mile
8L-1-166	8V-92TA	Hydraulic	1.0	16	3.33:1	488	26,000
8L-1-160	8V-92TA	Manual	1.0	14	3.33:1	488	22,750
8L-1-162	8V-92TA	Hydraulic	1.0	14	3.33:1	488	22,750
8L-1-164	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000
8L-1-168	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000

CALIFORNIA DDEC II ENGINES

MCI Engine Part Number	Engine	Transmission	Top Gear Ratio	Sensor Pulses Per Revolution	Axle Ratio	Tires Revolutions Per Mile	Pulses Per Mile
8L-1-167	8V-92TA	Hydraulic	1.0	16	3.33:1	488	26,000
8L-1-161	8V-92TA	Manual	1.0	14	3.33:1	488	22,750
8L-1-163	8V-92TA	Hydraulic	1.0	14	3.33:1	488	22,750
8L-1-165	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000
8L-1-169	8V-92TA	ATEC	1.0	16	3.33:1	488	26,000

MCI INSTALLED STANDARD SIZE TIRES

Mfr.	Brand	Size	Rev/Mile
Goodyear	Low Profile	B305/75R x 22.5	510
Goodyear	Unisteel II	12.00R x 22.5	486
Goodyear	Unisteel II	12.75R x 22.5	485
Firestone	HP2000	315/BOR x 22.5	488
Firestone	HP2000	12.00R x 22.5	486
Michelin	XZA; XM+SA	12.00 x 22.5	487
Bridgestone	R290	12.00 x 22.5	491
Kelly Springfield	KSR Radial	12.00 x 22.5	486

Pulses per Mile = (Sensor Pulses per Revolution) x (Axle Ratio) x (Revolutions per Mile).

An example of such a calculation is:

With a combination of an 8J-1-37 Engine with 3.73:1 Axle Ratio and Goodyear Low Profile Tires:

Pulses per Mile = 16* x 3.73 x 510** = 30,437

* From Table
** From Tire Chart

Change the factory programmed 26,000 pulses per mile (shown in the table for the 8J-1-37 engine) to 30,437 pulses per mile.

SECTION 8D

JACOBS ENGINE BRAKE SYSTEM

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

The Jake Brake™ engine brake feature effectively converts a power producing diesel engine into a power absorbing air compressor.

Generally, all Jake Brake™ engine brake installations operate in much the same manner. The basic difference between engine brake function is the number of brake modules (one per cylinder) utilized in the installations. The engine brake feature may be selected for either a half-force or full-force application depending on the amount of power to be absorbed.

The engine brake mechanically opens the cylinder exhaust valves near the top of the normal compression stroke, and releases the compressed cylinder charge to create an exhaust blowdown. Blowdown of the compressed air to atmospheric pressure prevents return energy for engine operation on an expansion stroke, the effect being a net energy loss since work done in compressing the cylinder charge is not utilized.

COMPONENTS

There are very few components in a typical engine brake installation. Some of the main components are the housing assembly, the selector switch, wire harness and any related switches associated with other equipment.

HOUSING ASSEMBLY

The main component of the engine brake is the housing assembly, (one per cylinder). The housing is mounted atop the cylinder head above each set of exhaust valves and the injector.

The housing assembly includes the master and slave pistons, the control valve with ball check, oil accumulator, the solenoid valve, and internal oil passages.

SELECTOR SWITCH

The selector for the engine brake feature is a three position type switch, located on the left hand switch panel.

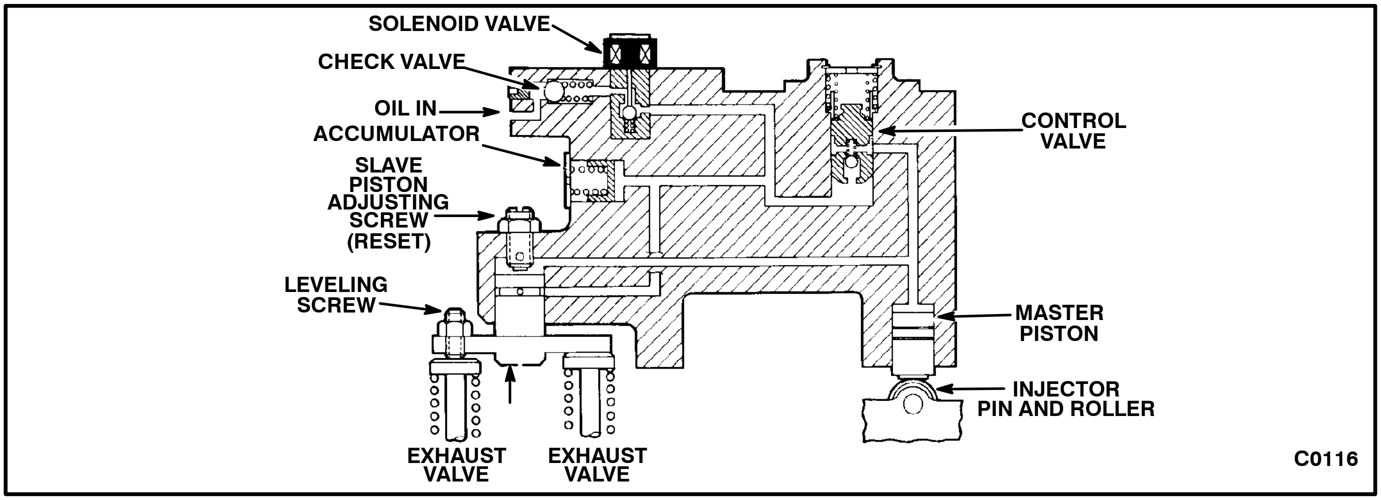

Figure 1. Engine Brake Operational Schematic (Series 60)

OPERATION

The following is a simplified version of the operational sequence for a typical engine brake cycle (Figure 1).

A. Energizing the engine brake solenoid valve permits engine lube oil to flow under pressure through the control valve into the master and slave piston circuit.

B. Oil pressure causes the master piston and its extension to move down, coming to rest on the injector rocker clevis.

C. The injector rocker clevis begins upward travel (as in normal injection cycle) forcing the master piston upward and creating a high pressure oil flow to the slave piston. The ball check valve in the control valve imprisons high pressure oil in the master slave piston system.

D. The slave piston under the influence of the high pressure oil flow moves down momentarily opening the exhaust valve while the engine piston is near its top dead center position releasing compressed cylinder air to the exhaust manifold.

E. Compressed air escapes to atmosphere completing a compression braking cycle.

To retard a coach on a downgrade using the Jake Brake™, the operator selects a gear which will provide a balance between engine speed and road speed. If the engine speed exceeds maximum rated rpm, for a desired road speed, a higher gear can be selected, or intermittent use can be made of the vehicle service brakes.

The selection of successively lower gears will generally allow complete control of the vehicle by the Jake Brake™ leaving the vehicle service brakes in reserve to be used for emergency stops. After some practice most drivers will know what combination of gears will give the best results over a particular route.

MAINTENANCE

The Jacobs engine brake installations are relatively trouble-free. However, inspections to and adjustments of the installations along with parts replacement will need to be made periodically. Use the following procedures to access the installations when needed.

Note: Series 60 and some Caterpillar six cylinder engine installations are fitted with Jacobs engine brakes on the number 1 through 4 cylinders only. 8V-92 and Cummins installations have brakes on every cylinder.

SOLENOID VALVE REMOVAL

Note: Refer to the “Housing Components” illustration (Figures 15 16).

Note: Most engine brake installations will allow the solenoid valves to be removed from the housing while housing is still attached to the cylinder head.

1. Remove the valve cover from the engine.
2. Disconnect the wiring from the solenoid valve.
3. Using 7/8 inch socket and extension, unscrew solenoid valve (Figure 2).

⚠ CAUTION ⚠

Do not disassemble or tamper with the solenoid valve. The solenoid valve contains no serviceable parts.

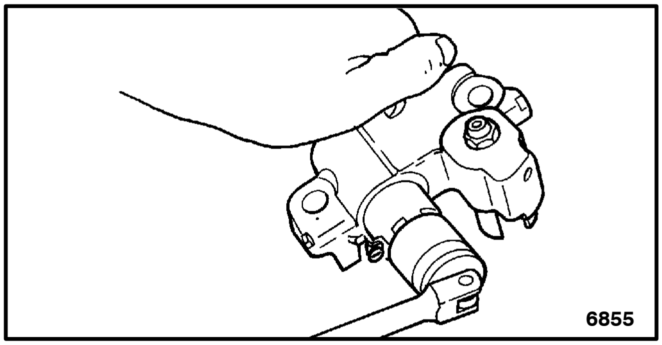

Figure 2. Remove Solenoid Valve

4. Remove and discard the three rubber O-ring seals (Figure 3) the lower ring stays in the bottom of housing solenoid bore, remove with a piece of wire.

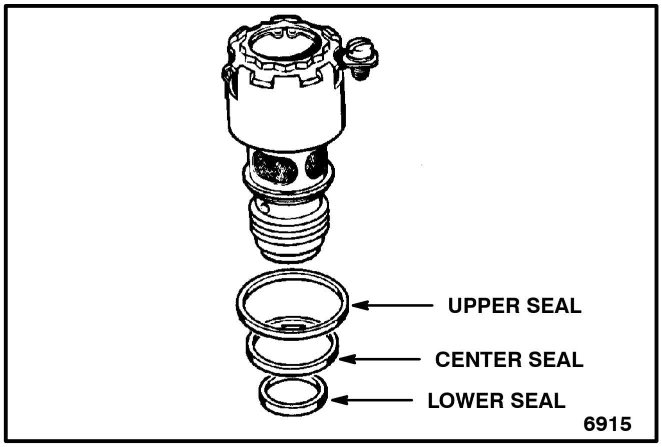

Figure 3. Remove Solenoid Valve Seals

5. Clean the solenoid valve with approved cleaning solvent. Use a brush to clean the oil screen. Dry the valve with compressed air.
6. Clean the solenoid valve bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.
7. Coat the new solenoid O-ring seal with clean lube oil before installing.

8. Install the upper and center O-ring seals on the solenoid body, and the lower seal ring into the bottom of the solenoid bore in the housing (Figure 4).

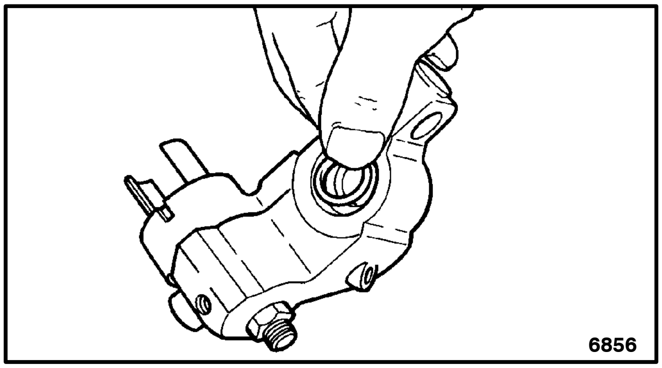

Figure 4. Install Solenoid Valve Seals

9. Be sure the seals are seated properly and carefully screw the solenoid into housing without unseating the seals. Torque the valve to 60 in-lbs (7 N·m). Be careful not to twist the seals while installing.

CONTROL VALVE REMOVAL (8V-92)

Note: Refer to the “Housing Components” illustration (Figure 15).

1. Remove the Jake Brake™ housing assembly from the cylinder head.

Note: Removal of the housings can accomplished by reversing the system installation procedure for housings shown later in this sub-section.

WARNING

Remove control valve covers carefully. Control valve covers are under load from the control valve springs. Remove with care to avoid personal injury.

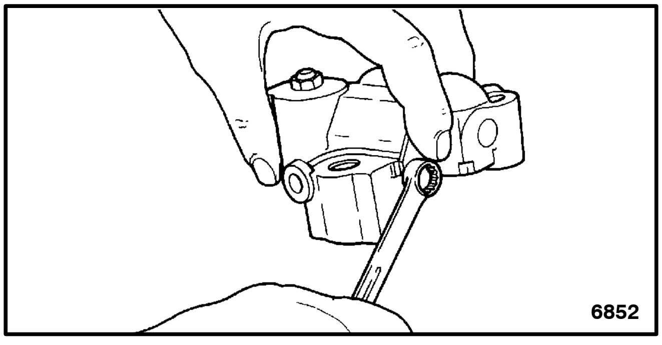

Figure 5. Remove Control Valve Cover Capscrew

2. Apply pressure to the control valve cover and carefully remove the control valve cover capscrew (Figure 5).

3. Slowly remove cover until spring pressure ceases, then remove the two control valve springs (Figure 6).

4. Using needle-nose pliers, reach into the bore and grasp the stem of the control valve. Pull valve straight up and out of its bore (Figure 7).

5. Wash the control valves with approved cleaning solvent. Push a wire through the hole in the base of the valve to ensure that the ball check is free. The ball should lift with light pressure on the wire. Dry the valve with compressed air and wipe clean with a paper towel.

6. Clean out the control valve bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.

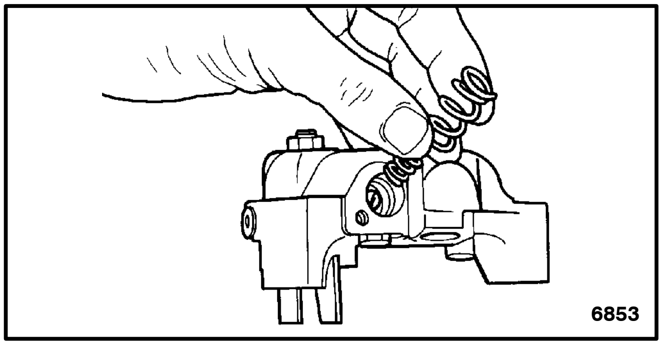

Figure 6. Remove Control Valve Springs

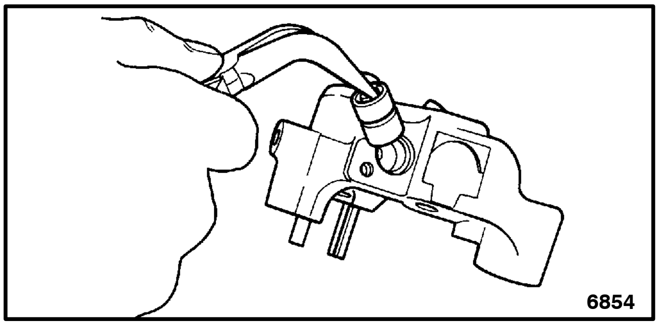

Figure 7. Remove Control Valve

7. Dip the control valves in clean lube oil. Holding the valve by the stem, let the valve drop into its bore. If binding occurs or if the ball is stuck in the valve, the control valve should be replaced.

8. Reassemble parts reversing removal procedure.

CONTROL VALVE REMOVAL (SERIES 60)

Note: Refer to the “Housing Components” illustration (Figure 16).

WARNING

Remove the control valve retaining rings carefully. Control valves are under load from the control valve springs. Use care in removing to avoid personal injury.

1. Remove the Jake Brake housing assembles from the cylinder head by reversing the system installation procedure for housings.

2. Press down on the control valve washer using an appropriate rod to relieve spring pressure

3. Remove retaining ring using retaining ring pliers.

4. Continue by following steps 4 through 8 of the previous procedure.

SLAVE PISTON REMOVAL (8V-92)

Note: Refer to the "Housing Components" illustration (Figure 15).

WARNING

Wear safety glasses. Remove slave piston carefully. The slave piston is retained by springs that are under heavy compression. If the following instructions are not followed and proper tools not used, the spring could be discharged with enough force to cause personal injury.

1. Remove the locknut on the slave adjusting screw. Back out the adjusting screw until the salve piston is fully retracted (screw is loose) (Figure 8).

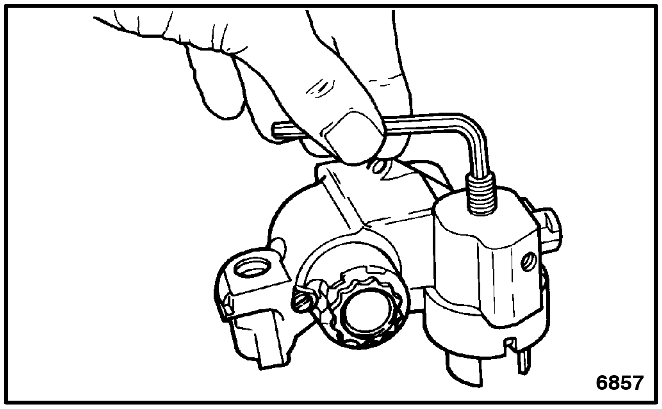

Figure 8. Remove Slave Piston Adjusting Screw

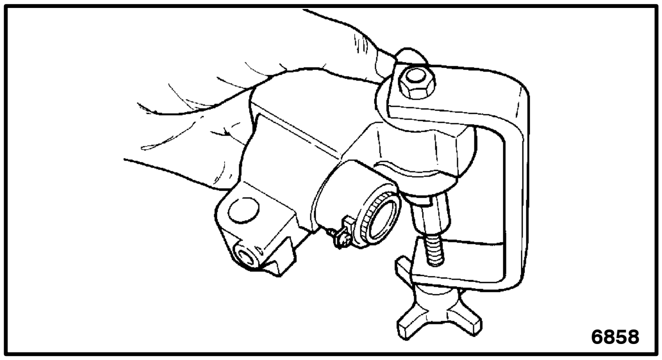

Figure 9. Remove Slave Piston

2. Using the slave piston clamp fixture, place the hole in the clamp fixture over the slave piston adjusting screw. Replace locknut and snug tight to hold fixture securely (Figure 9).

3. Hold the fixture and screw the ram down over the slave piston until the retainer is contacted. Turn the handle slowly until the retainer and spring are depressed about 0.04 inch (1 mm) relieving pressure against the slave piston's retaining ring.

4. Remove the retaining ring. Use retaining ring pliers. Back the ram off until the springs are loose and remove the fixture (Figure 10).

5. Remove, clean and inspect all components ensuring there is no binding or burrs. (Figure 11).

6. Clean the slave piston bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.

7. Reverse steps 2, 3 and 4 to reinstall piston and spring. Be sure retaining ring is placed on the retainer before screwing the clamp holder down over the slave piston (Figure 12).

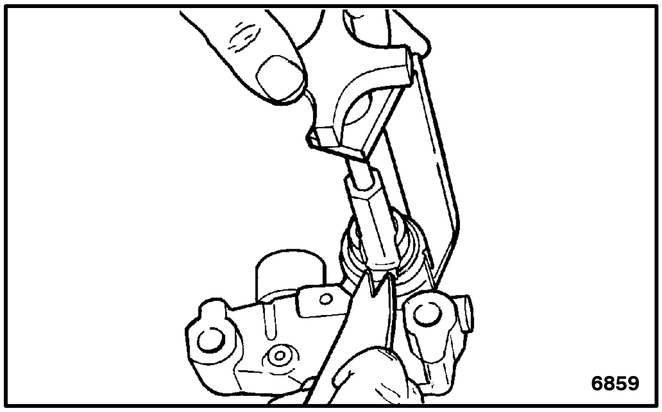

Figure 10. Remove Retaining Ring

NOTE: Be sure all components are reassembled in proper order.

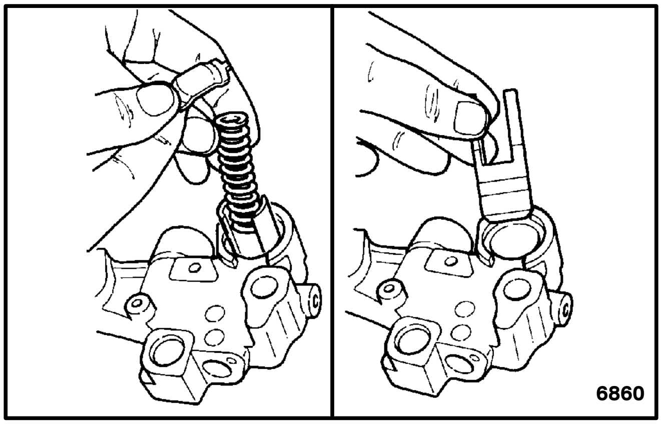

Figure 11. Slave Piston Removal & Replacement

8. Compress the slave piston and spring down until the retainer is about 0.04 inch (1 mm) below the retaining ring groove. Reinstall the retaining ring. Be sure this retaining ring is fully seated in the groove.

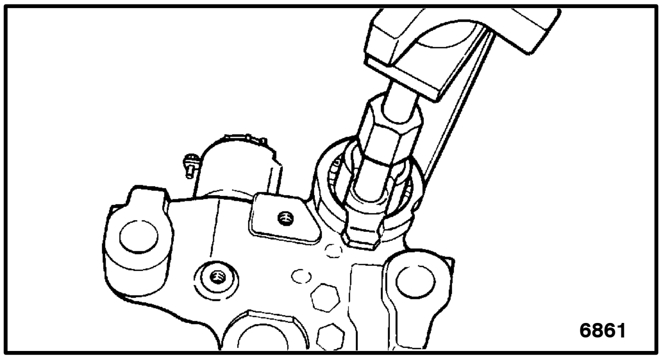

Figure 12. Install Slave Piston

9. Rotate retaining ring 90 degrees in either direction to assure setting of same.

⚠ CAUTION ⚠

Do not leave the opening of the retaining ring aligned with opening in the housing as this will allow the spring retainer to become loose when the engine brake is operating. Serious engine damage will result.

10. Remove the clamp fixture slowly to ensure proper seating of retaining ring.

SLAVE PISTON REMOVAL (SERIES 60)

Note: Refer to the “Housing Components” illustration (Figure 16).

1. Remove the capscrew and torsion spring that retains the slave piston and bridge assembly.
2. Remove the bridge and piston from its bore.
3. Loosen the leveling screw locknut and remove the leveling screw from the bridge.
4. Continue by following steps 5 and 6 of the previous procedure.
5. Reinstall, via reverse procedure with the leveling screw toward the center of the housing.
6. Position the torsion spring with the ends over bridge grooves.
7. Install the spring capscrew and torque to 15 ft-lbs (20 N·m).

⚠ CAUTION ⚠

While tightening the screw on the torsion spring, push the sprig towards the slave piston assembly. Failure to do so may result in contact between the intake valve adjusting screw and torsion spring, resulting in serious engine damage.

MASTER PISTON REMOVAL (8V-92)

Note: Refer to the “Housing Components” illustration (Figure 16).

1. Remove button head screw, lock plate, and master piston spring from housing (Figure 13).

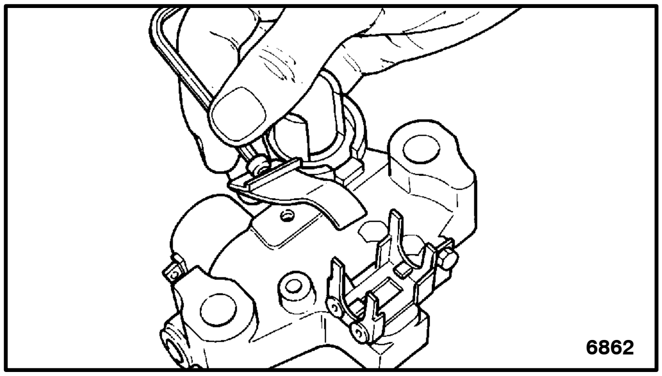

Figure 13. Remove Master Piston Spring

2. Remove fork assembly and the master piston should slide out of its bore (Figure 14).
3. Remove, clean and inspect all components ensuring there is no binding or burrs.
4. Clean the slave piston bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.

5. Reassemble components reversing above procedure.

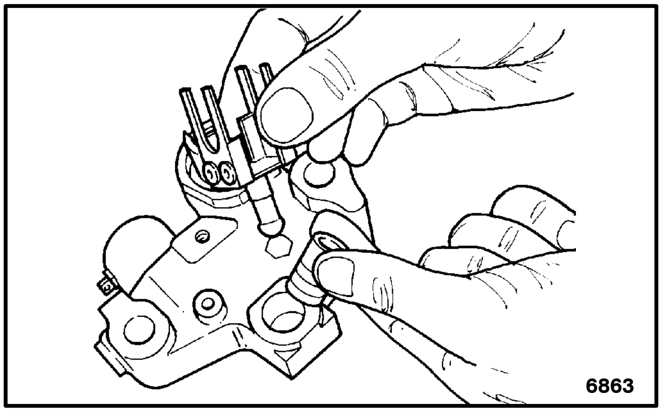

Figure 14. Remove Master Piston

MASTER PISTON REMOVAL (SERIES 60)

Note: Refer to the “Housing Components” illustration (Figure 16).

1. Remove master piston retaining spring capscrew from housing and slide piston out of its bore.

2. Remove, clean and inspect all components.

3. Clean the slave piston bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.

4. Lube the master piston and insert into bore. the piston should move freely without binding.

5. Reverse the procedure to assemble piston and torque to100 in-lbs (10 N·m).

SYSTEM INSTALLATION

Before beginning clean and remove the rocker covers (Figure 17). The engine is equipped with an aluminum two piece valve cover, remove only the upper cover to access engine brake. Removal of the fuel supply and drain tubes may allow easier access. To remove the tubes loosen nuts on injector and risers at back of cylinder head Save all fuel tubing for reuse (Figure 18).

Note: Some procedures and/or steps herein will be specifically addressing the retrofitting of Jake Brakes™ to existing engines. These procedures and/or steps may not be applicable to normal maintenance tasks.

1	CAPSCREW, BUTTON HEAD
2	RETAINER, SPRING
3	SPRING, MASTER PISTON
4	FORK ASSY, NASTER PISTON
5	MASTER PISTON
6	RING, RETAINER
7	RETAINER, SPRING
8	SPRING, SLAVE PISTON
9	SLAVE PISTON
10	NUT, HEX JAM
11	SET SCREW
12	CAPSCREW, HEX HEAD
13	COVER, CONTROL VALVE
14	SPRING, CONTROL VALVE, ORANGE
15	SPRING, CONTROL VALVE, WHITE
16	CONTROL VALVE
17	SOLENOID VALVE
18	SEAL, UPPER-SUPPLY HSG.
19	SEAL, CENTER-SUPPLY HSG.
20	SEAL, LOWER-SUPPLY HSG.
21	SEAL RING
22	CONNECTOR, OIL
23	NUT, HEX JAM

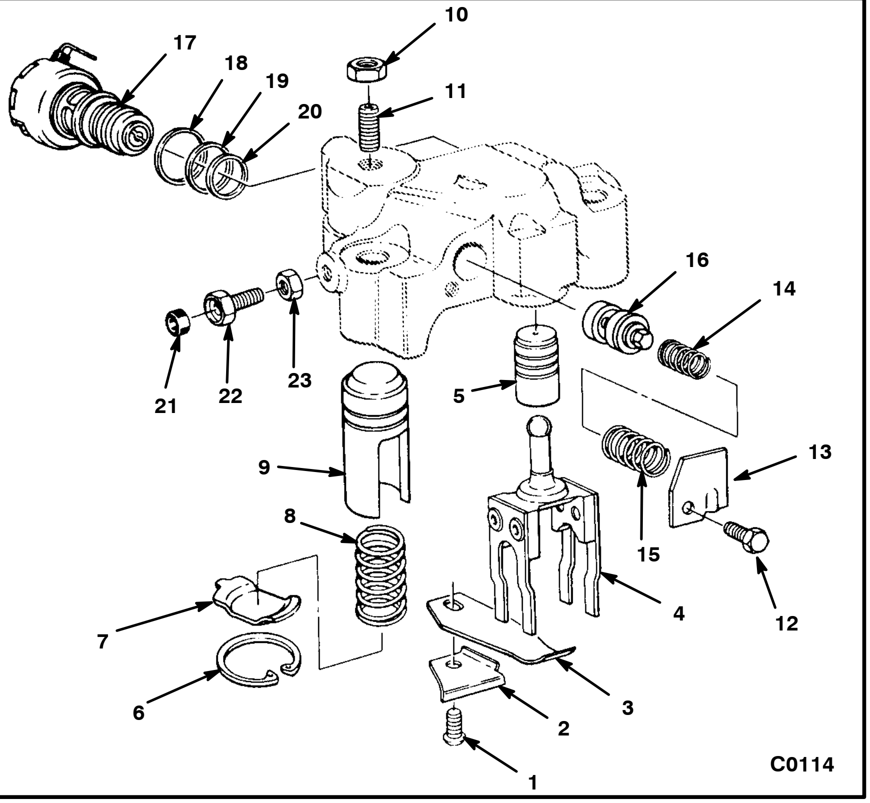

Figure 15. Engine Brake Housing Assembly (8V-92)

1	RETAINING RING
2	WASHER
3	STOP SPRING
4	SPRING
5	COLLAR
6	CONTROL VALVE
7	SOLENOID VALVE
8	SEAL RING, UPPER
9	SEAL RING, CENTER
10	SEAL RING, LOWER
11	SPRING
12	PISTON, ACCUMULATOR
13	RESET SCREW ASSY, HEX NUT
14	SCREW
15	FLAT SPRING
16	FLAT SPRING
17	MASTER PISTON
18	ADJUSTING SCREW
19	HEX NUT
20	SLAVE PISTON
21	BRIDGE
22	TORSION SPRING
23	BUTTONHEAD SCREW

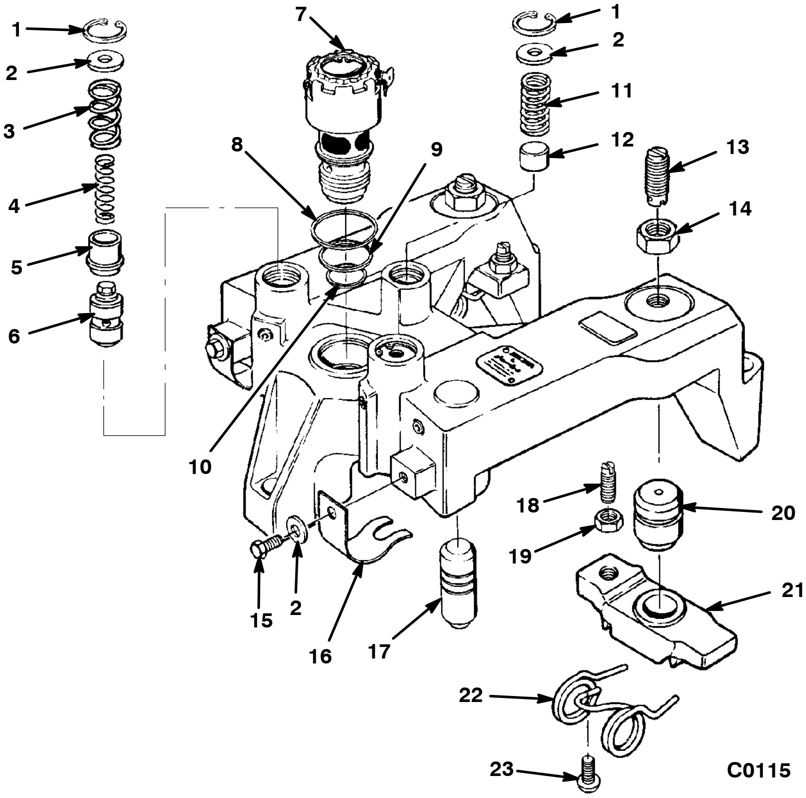

Figure 16. Engine Brake Housing Assembly (Series 60)

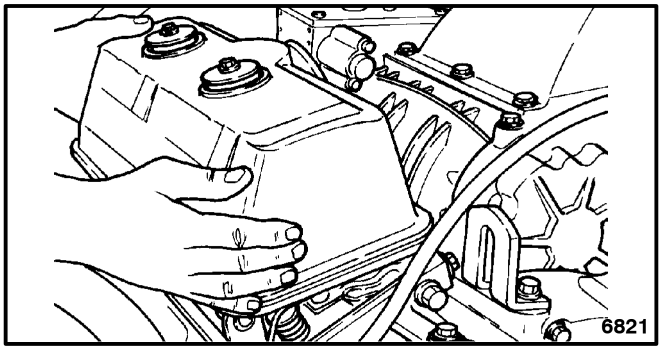

Figure 17. Removing Rocker Cover (8V-92)

Exhaust Valve Bridges (8V-92)

1. Remove the rocker bracket holddown bolts, and move the the rocker shaft so that the exhaust valve bridges can be removed (Figure 19).

2. Remove adjusting screws from exhaust valve bridges and insert into the Jacobs bridge (Figure 20).

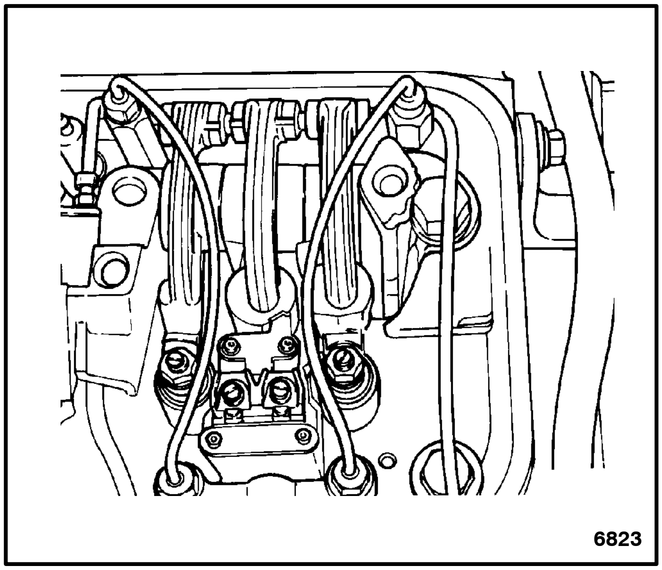

Figure 18. Removing Fuel Supply And Drain Pipes

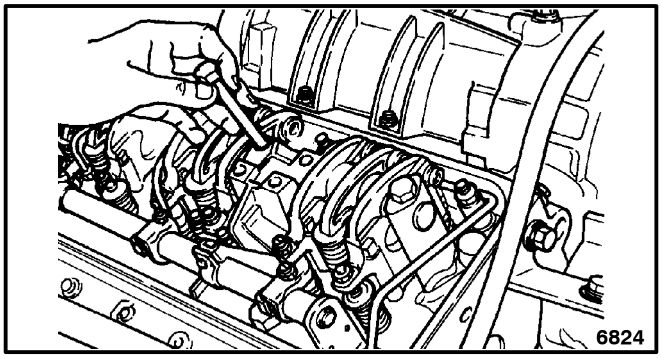

Figure 19. Removing Rocker Bracket Hold Downs

CAUTION

When loosening the locknut, hold bridge in vise. Do not loosen locknut while bridge is installed in engine as valves may be bent resulting in engine damage.

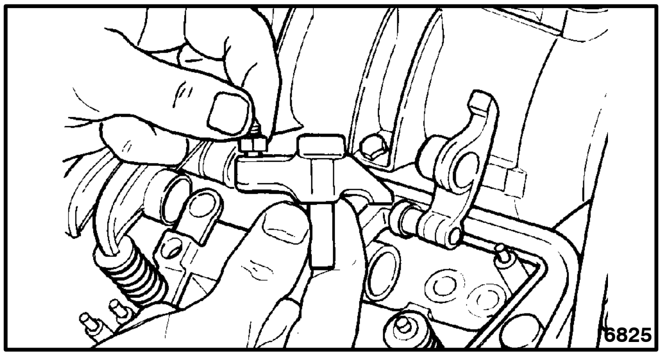

Figure 20. Replacing Exhaust Valve Bridge

3. While pressing straight down on the pallet surface of the valve bridges, turn the adjusting screw clockwise until if just touches the valve stem. Then turn the adjusting screw an additional 1/8–1/4 turn clockwise and tighten the locknut finger tight (Figure 21).

4. Remove the bridge and place in a vise (or holding fixture as illustrated). Hold the adjusting screw with a screwdriver and torque the locknut to 22 ft.lbs (30 N·m) (Figure 22).

5. Lubricate the valve bridge guide pin and install the bridge in its original position. Place a 0.0015-inch (0.0038 mm) feeler gauge under each end of the valve bridge (Figure 23).

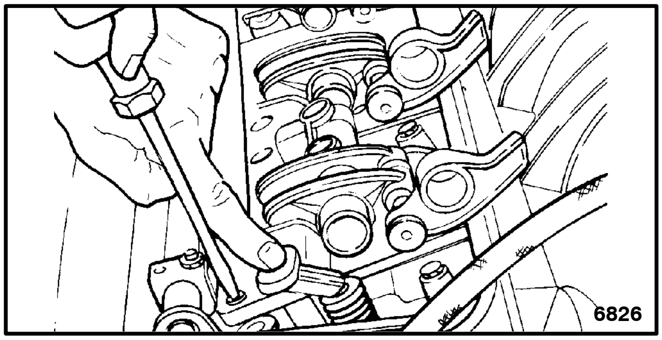

Figure 21. Adjusting Valve Bridge Screw

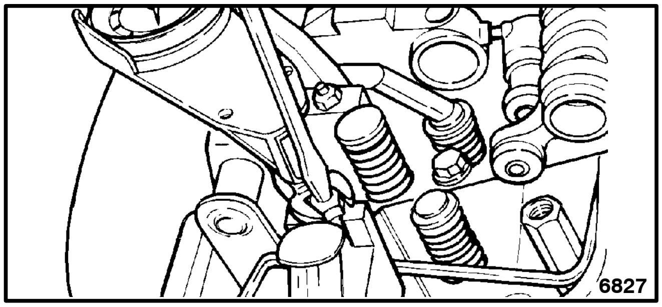

Figure 22. Tighten Locknut

NOTE: A narrow strip of 0.0015-inch feeler stock must be used under the locating groove over the inner exhaust valve.

NOTE: While pressing down on the pallet surface of the bridge, both feeler gauges must be tight. If the gauges are not tight, readjust the bridge.

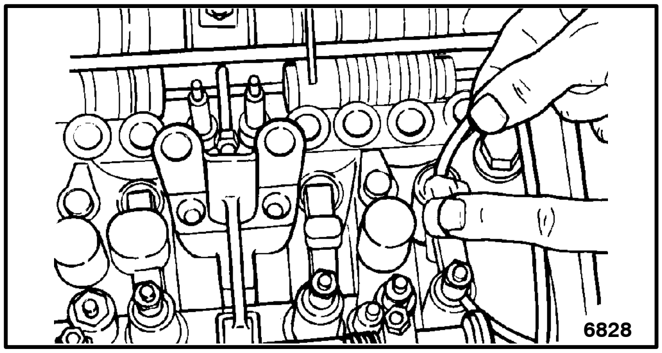

Figure 23. Install Valve Bridge

6. Some engines may have rocker arms having an oil drill boss. If boss is present, remove right-hand rocker arm and grind off boss. This is done to provide clearance for the slave piston (Figure 24).

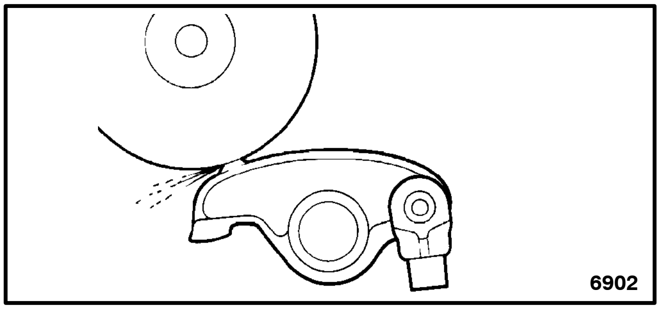

Figure 24. Remove Oil Drill Boss

Fuel Piping

7. Apply clean lube oil to the flare connector of the Jacobs fuel tube fittings (Figure 25).

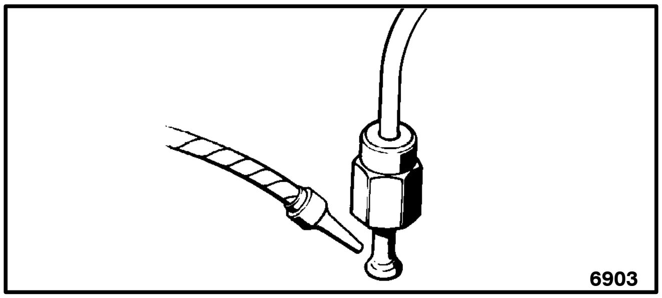

Figure 25. Apply Oil to Fuel Pipe Flare

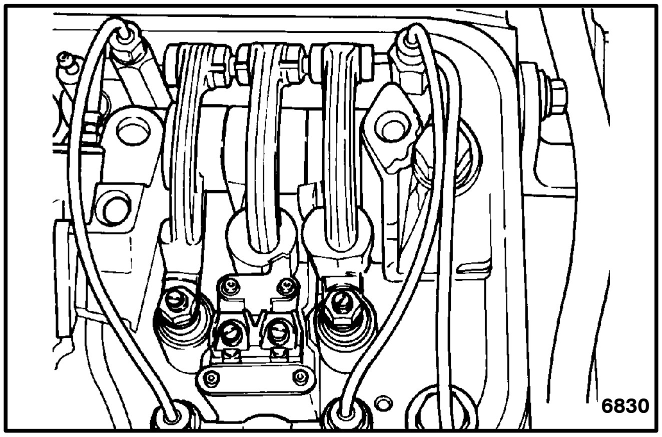

Figure 26. Install Fuel Pipes With Bend Outward

8. Reinstall the fuel tubes turning them 180 degrees from their original installed position. The bend in the fuel tubes must be aimed away from the injector (Figure 26).

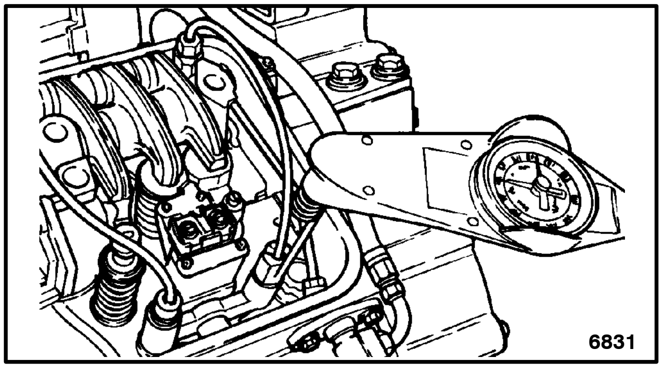

Figure 27. Tighten Fuel Pipe Nuts

9. Tighten the fuel tube connector nuts to 140 in-lbs (16 N·m) (Figure 27).

CAUTION

This torque specification is critical and should be strictly maintained. Any deviations may cause fuel pipe failure and may result in serious engine damage.

Brake Housing (8V-92)

Note: Prior to installing the Jake Brake housings onto the engine, laid out the complete installation using the Jacob installation booklet.

Note: Steps 1 through 4 are used only in installations requiring oil links between housings (8V-92).

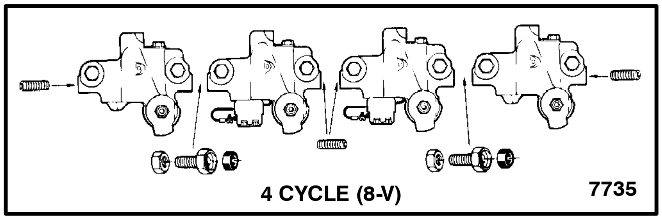

Figure 28. Jacobs Brake Housing Layout

1. The oil jumper screws and seal rings and end plugs should be installed as indicated (Figure 28).

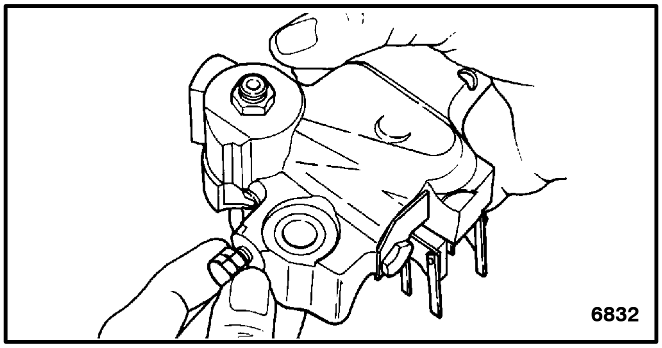

Figure 29. Inserting Oil Jumper

2. Insert oil jumper with locknut into housing. Turn in approximately ½ inch (13 mm) to avoid damage during assembly on the engine (Figure 29).

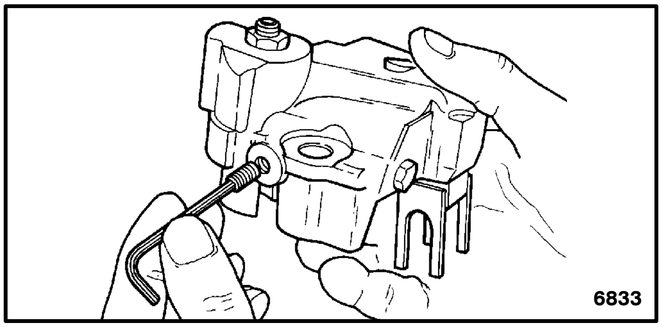

Figure 30. Insert and Tighten Plugs

3. Insert and tighten the 5/16-24 plugs on outboard side of end brake units (Figure 30).

4. Insert lube seal O-ring into the counterbore (Figure 31).

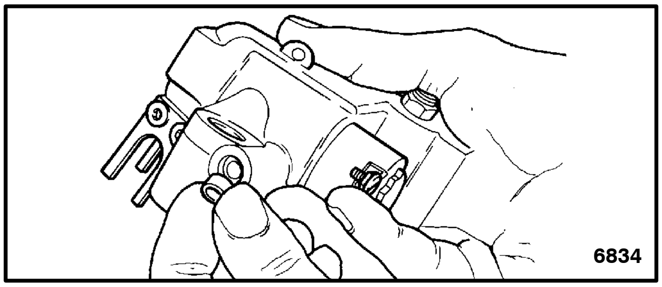

Figure 31. Inserting Lube Seal Ring

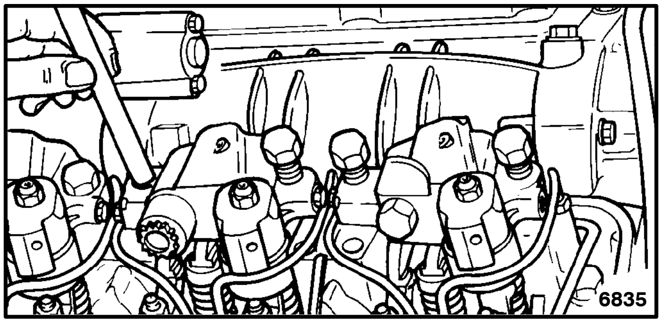

Figure 32. Position Jacobs Brake Housing

5. Install the Jacobs hold down capscrews into brake housing. Position housing over rocker assembly insuring the master piston fork guide is properly located over the injector push rod clevis (Figure 32).

CAUTION

CAUTION: Make sure that fuel tubing does not interfere or contact the engine brake housing. Fuel tube contact with the engine brake housing will cause failure of the tube and subsequent engine damage may result. Loosen and reposition housings if necessary to clear fuel tubes. Do not bend fuel tubes, as this may also cause a fuel tube connection failure.

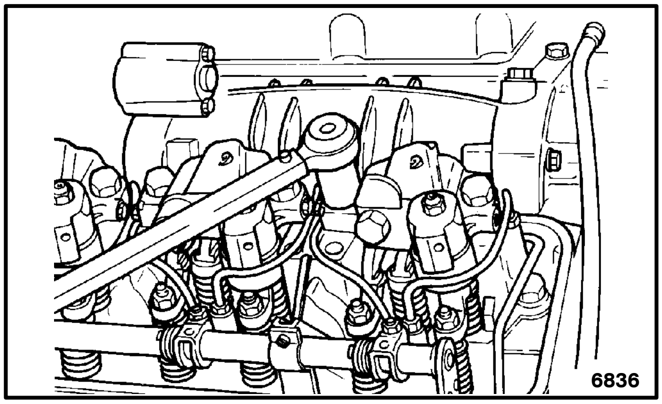

Figure 33. Tighten Hold Down Bolts

6. Tighten hold down bolts to 90 ft-lbs (120 N·m) torque (Figure 33).

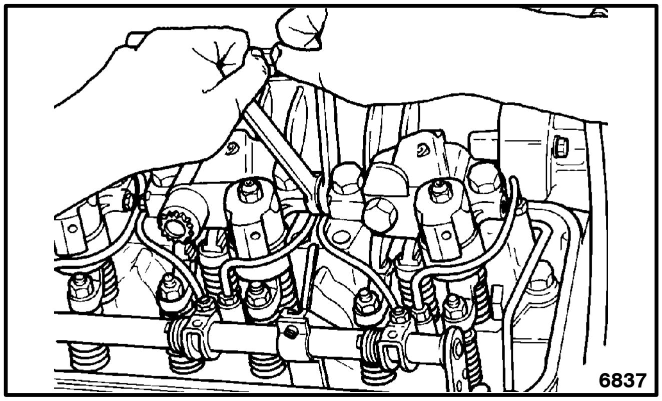

Figure 34. Check Seal Rings

7. Reposition housings if necessary, to ensure proper fit of the seal O-ring into the oil jumper screw. Back out the oil jumper screw until contact is made with adjacent housing.

Then back off the screw 1/2 turn from contact point to establish working clearance. Hold screw in this position and tighten the locknut (Figure 34).

⚠ CAUTION ⚠

If the screw is allowed to contact adjacent housing during brake operation the screw could break resulting in oil leakage and loss of engine braking. Oil for Jake Brake™ function is supplied via the cylinder head capscrew galleries.

Brake Housing (Series 60, Cat & Cummins)

Note: Some minor differences exist between these installations, i.e. housing configurations. Follow the Jacobs Brake™ installation booklet that matches the specific engine being fitted. For convenience the following procedure will reflect a Series 60 installation.

If retrofitting Jake Brakes™ to existing engine, install the undercover wire harness before installing brake housings. See "Solenoid Valve Harness (Series 60)" procedure that follows. Secure the harness to the spacer bars only after mounting housings.

1. Remove the two front bearing capscrews on the intake manifold side.
2. Insert the two housing spacer bars on the exhaust manifold side of the cylinder head with the "out" markings adjoining each other and facing the exhaust manifold.
3. Place the two engine brake housings over the rocker shafts and spacer bars with the solenoid valves toward the camshaft side of the engine.
4. Install a washer onto each of the housing capscrews and insert into the housing (3 capscrews per housing).
5. Before torquing housing capscrews, move the housing from side to side and position at midpoint of movement.
6. Torque the housing capscrews per the following sequence.

A. Tighten camshaft side capscrews to 40 ft-lbs (55 N·m) torque.

B. Tighten exhaust side capscrews to 40 ft-lbs (55 N·m) torque.

C. Repeat the above sequence and torque to 80 ft-lbs (110 N·m).

Solenoid Valve Harness (8V-92)

1. Remove the steel plugs from the cylinder head locations as shown in (Figure 35).
2. Install the rubber wire supports to the fuel lines as shown, and connect the terminals to the solenoid valves.
3. Pass the harness through the cylinder head access holes and install the terminal bushing.

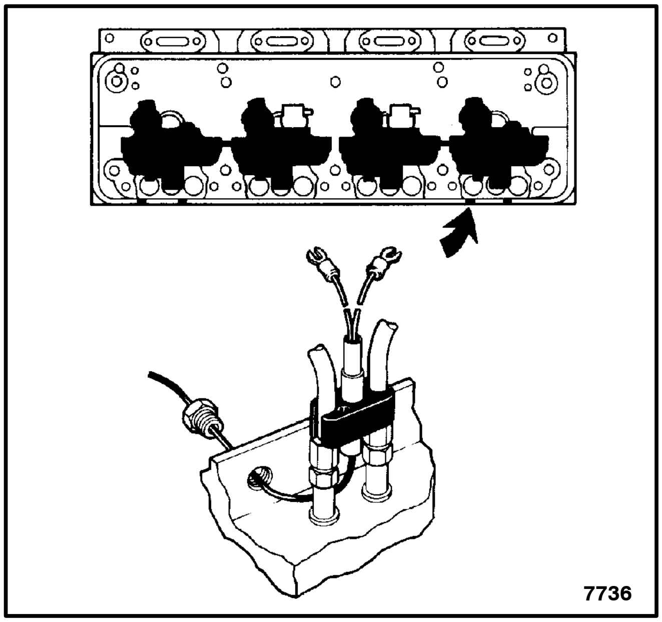

Figure 35. Solenoid Valve Harness Installation

4. Pull wire to take up slack between bushing and solenoid valve. Tighten bushing and effect a seal to prevent oil leakage using 7⁄16-inch six-point box end wrench (Figure 36).

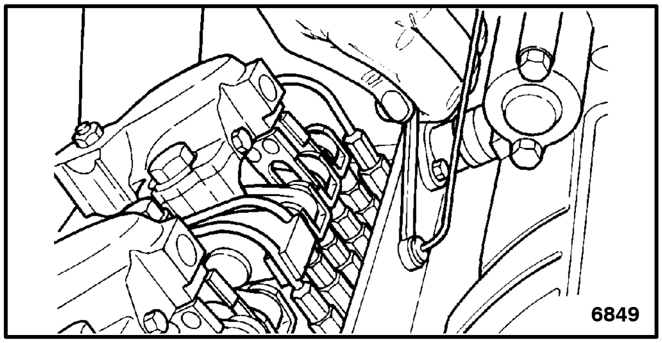

Figure 36. Set Slack With Bushing

Solenoid Valve Harness (Series 60)

1. Remove the mounting flange cover for the EUI harness at rear of cylinder head.
2. Insert the wires leads to the Jake Brake™ solenoid harness through the access holes in the grommet from outside in.

Note: Once the wires are inserted through the grommet, they cannot be removed due to the terminal's locking tangs.

3. Install the solenoid harness along side of the injector harness, with its end connector located outboard of the last rear harness standoff.

Note: Detroit Diesel factory installed harnesses have red wires instead of the yellow and blue wires used in the Jake Brake™ retrofit kits.

4. Insert the wire lead's pin housing into the undercover solenoid harness' connector.

5. Install pins to the ends of the wire leads, and insert the wire lead's pins into the housing.

Note: Do not reverse the wire lead to harness connection color codes, or improper engine brake sequencing will occur.

6. Bend all of the electrical terminals at the injectors upwards about 90 degrees to provide clearance for the engine brake housings.

Clutch Microswitch

A Jake Brake™ clutch microswitch is used with the standard transmission installations. The switch is normally closed when clutch is disengaged (pedal out) to permit Jake Brake™ operation. When clutch is engaged (pedal in) the Jake Brake™ circuit is broken and Jake Brakes™ are momentarily off (during downshift).

The microswitch is mounted to the clutch pedal mounting bracket attached to the driver's kick panel. (Figure 37). The proper positioning of the microswitch allows the switch to be activated during clutch pedal play before actual clutch disengagement occurs.

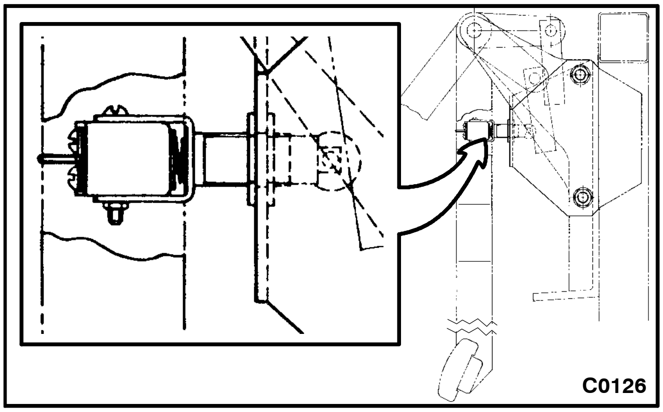

Figure 37. Clutch Microswitch Mounting

Positioning of the switch is done by means of the jamnuts which hold the switch to its bracket. Loosen and tighten these nuts to achieve the desired direction of movement of the switch towards or away from the clutch shaft lever.

When positioning the switch, avoid placing it so close to the lever arm that the switch contacts are damaged by excessive pressure.

Dash Mount Switch

The Jacobs engine brake switch is located in the lower center of the right-hand switch panel, to the right side of the driver (Figure 38).

The switch contacts are protected against arcing by a small diode connected between the load side solenoid valve switch terminals and ground. The engine brake must be connected to the load side terminal. Refer to the Jacobs Engine Brake wiring diagram in sub-section 7J.

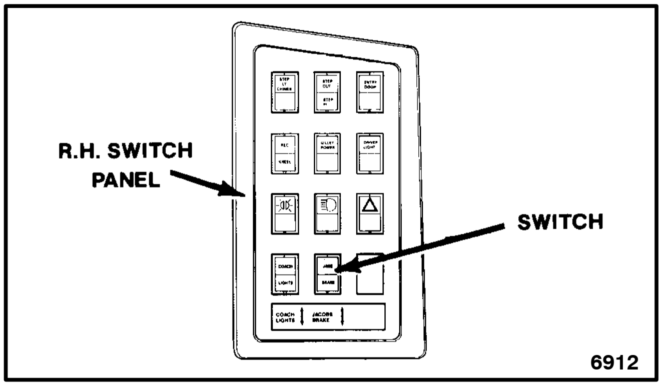

Figure 38. Jacobs Engine Brake Switch

Half or full operation of the engine brake may be selected by moving the switch on the dash to the intermediate position for operating half of the engine brakes, or by moving it to the upper position which brings both engines banks into operation.

When the switch is in the fully downward position, the engine brake is off.

Engine braking will not begin unless the driver's foot is removed from the accelerator pedal.

ADJUSTMENTS

The following are general adjustment procedures for setting the intake/exhaust valves, injectors and slave piston clearance.

For specific information on settings and tools consult the engine manufacturer's service publications and/or the engine data plate located on the engine.

Fuel Injector Height (8V-92)

1. Rotate the engine until the exhaust valves are fully depressed for the cylinder to be adjusted.

Note: If the crankshaft pulley bolt is used to turn the engine use only a clockwise rotation.

2. Place the injector timing gauge in the hole provided in the top of the injector body with the flat of the gauge toward the injector follower (Figure 39).

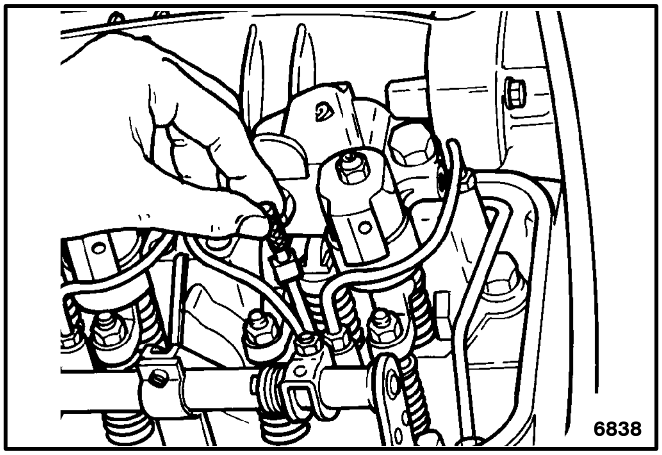

Figure 39. Insert Injector Timing Gauge

3. The flat of the injector gauge should just pass over the top of the injector follower. If it does not, loosen the push rod locknut and turn the push rod to obtain the proper clearance (Figure 40).

4. Hold the push rod and tighten the locknut (Figure 41). Adjust all the remaining injectors in the same manner as outlined above. Follow the firing order for the specific engine being adjusted.

Fuel Injector Height (Series 60)

1. Rotate the engine until any one of the injector followers has just begun its downward stroke and note the number of this cylinder.

> **Note:** The Timing Circle Method may be used to adjust Series 60 engine injectors and valves.

2. Follow steps 2 through 4 of the previous procedure and torque locknuts to 35 ft-lbs (47 N·m).

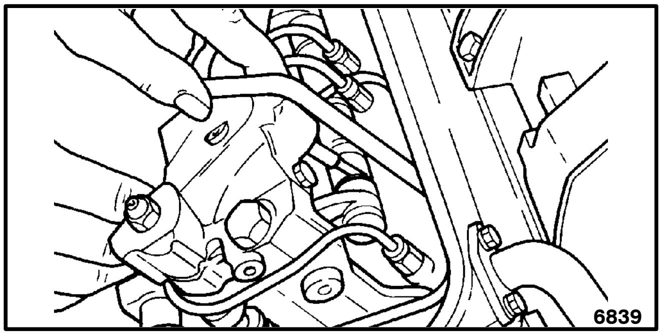

Figure 40. Check Injector Timing Clearance

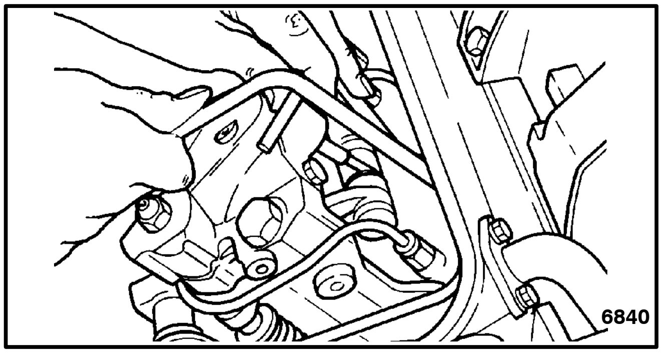

Figure 41. Tighten Locknut

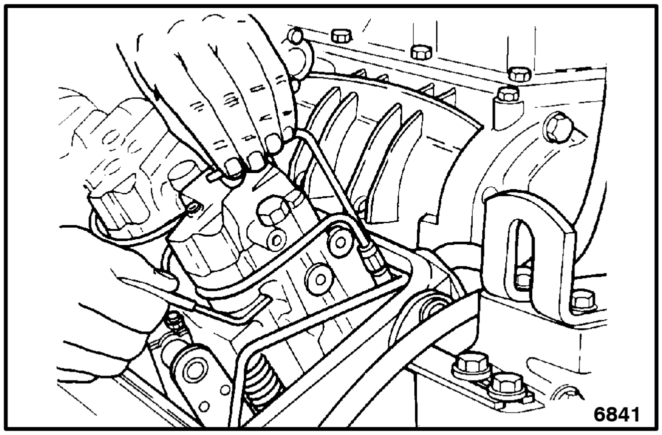

Figure 42. Insert Governor Stop Lever

Exhaust Valves

1. Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

2. Loosen the exhaust valve rocker arm push rod locknut (Figure 42).

3. Place a feeler gauge between the valve bridge and the valve rocker arm pallet. Adjusting the push rod to obtain a smooth pull on the feeler gauge.

> **Note:** Checking and Setting feeler gauge dimensions can be found in the specifications at the end of this sub-section.

4. Remove the feeler gauge. Hold the push rod with a 5/16-inch wrench and tighten the locknut with a 1/2-inch wrench (Figure 43).

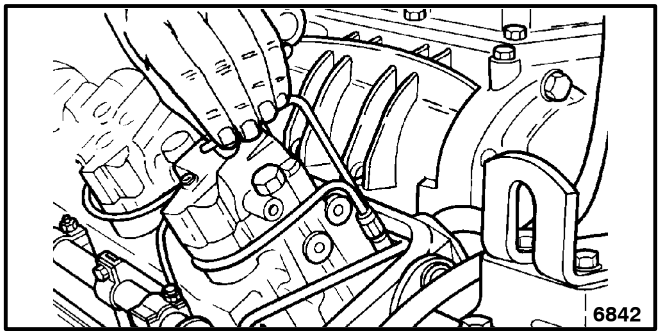

Figure 43. Tighten Pushrod Locknut

5. Check the clearance using the check dimensions for the specific engine.

Exhaust Valves (Series 60)

1. Follow the exhaust valve procedure above and use the clearances shown in the specifications.

Fuel Modulator (8V-92)

Some early model D Series coaches equipped with non-electronically controlled engines may have a fuel control device that might require adjustment after the engine brake has been installed.

The system requires special tools, gauges and adjustment procedures. It is recommended that Detroit Diesel service manuals and topics be consulted for specific instructions regarding the fuel control system adjustment.

Slave Piston Clearance (8V-92)

CAUTION

To prevent engine damage by piston to valve contact, the following instructions must be followed carefully. Prior to making slave piston adjustments, ensure exhaust valves are closed and injector is in delivery position.

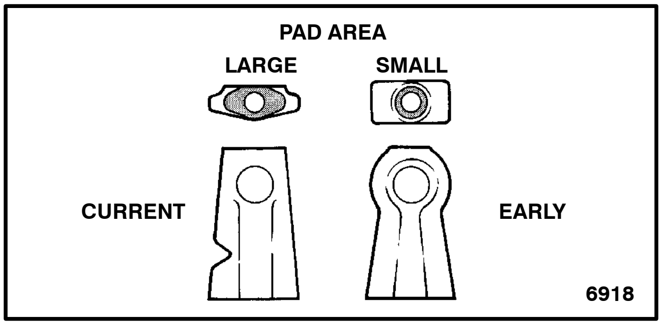

Figure 44. Rocker Brackets

NOTE: Use an 0.059 inch clearance setting with later style housings (Model 92A) and rocker shaft brackets with the larger pad area (Figure 44).

1. With engine stopped and exhaust valves closed, insert the correct feeler gauge between slave piston feet and valve stem cap.

2. Turn adjusting screw in until proper clearance is achieved as indicated by a slight drag on feeler gauge.

NOTE: Check both feet of slave piston and establish a setting with minimum clearance.

3. Hold adjusting screw in this position and tighten locknut to18 ft.lbs (24 N·m) torque (Figure 45).

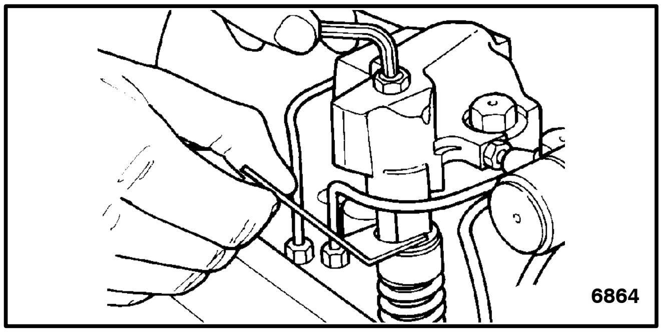

Figure 45. Set Slave Piston Clearance

OPERATIONAL CHECK

CAUTION

Always check the fuel system for leaks after injector or fuel pipe replacement and any time the fuel connections under the rocker cover are suspected of leaking. Failure to correct a serious fuel leak in the area can lead to dilution of the lube oil and bearing and/or cylinder wall damage.

After operating the engine for 20-30 minutes shut it off and remove the rocker covers. Inspect the lube oil puddles that normally form where the fuel connectors join the cylinder head and where the fuel pipes join the fuel pipe nuts.

If there is any leakage at a connection, the lube oil puddles will appear smaller or thinner than the puddles on connectors that are not leaking. Disassemble, inspect, and correct or replace the suspect part (connector washer, connector, injector or jumper line). Test and reinspect.

Never remove any engine brake component with engine running. Personal injury may result.

1. The Jake Brake™ dash switch should be in the "OFF" position, (engine brake solenoid not energized).

2. Move the shift selector to "Neutral" with the clutch pedal released (clutch engaged)

3. Start the engine and allow to warm up for a few minutes.

4. Move the dash switch to the Half-Force braking position.

5. Accelerate the engine above idle and release throttle pedal.

Note: Only one bank should operate during engine deceleration and shut off just above idle speed.

Note: On non-electronically controlled engines, if the engine brake does not shut off before reaching idle speed or shuts off too early, reset the buffer screw adjustment.

6. Move the dash switch to the Full-Force braking position.

7. Accelerate the engine above idle and release throttle pedal.

Note: All engine brakes should operate during engine deceleration and shut off before reaching idle.

8. Depress the clutch pedal to open the contacts in the clutch switch. With the dash switch in Full-Force braking position, accelerate the engine and release the pedal. The engine brakes should not operate with the clutch disengaged (pedal depressed).

⚠ CAUTION ⚠

If any of the above conditions are not met, recheck all installation procedures for correctness.

9. Install rocker cover and gasket. Torque cover hold down bolts to 20 ft-lbs (27 N·m) t(Figure 46).

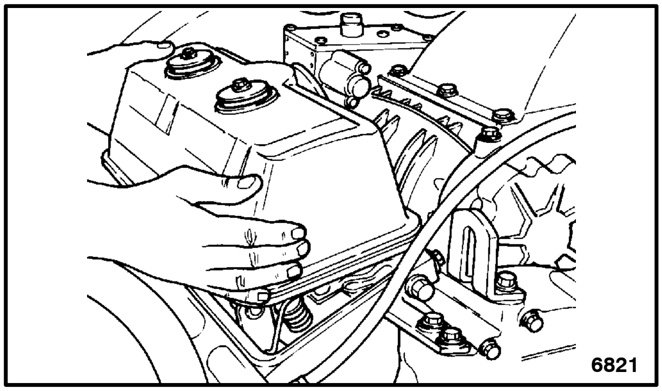

Figure 46. Install Rocker Cover

If the engine is equipped with current aluminum covers that are not the “high profile” design, they must be obtained from the Detroit Diesel Allison distributor. The high profile covers are designed specifically for engine brake installations (Figure 47).

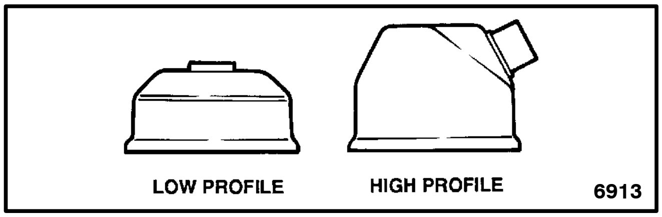

Figure 47. Rocker Cover Profile

SPECIFICATIONS

ENGINE BRAKE ASSEMBLY

Manufacturer	Jacobs Vehicle Equipment Company
Model Number (8V-92 Engine Installations)	92A
Model Number (11.1 Liter Series 60 Engine Installations)	760A
Model Number (12.7 Liter Series 60 Engine Installations)	765
Model Number (Caterpillar Engine Installations)	N/A
Model Number (Cummins Engine Installations)	N/A

HOUSING ASSEMBLY

Part Number	Model 92A (1993 Production) 17019 (24-Volt)
Part Number	Model 760A (1993 Production) 018974 (24-Volt)
Part Number	Model 760A (1994 Production) 017751 (12-Volt)
Part Number	Model 765 (1993 Production) 019032 (24-Volt)
Part Number	Model 765 (1994 Production) 017537 (12-Volt)
Part Number (Caterpillar Engine Installations)	N/A
Part Number (Cummins Engine Installations)	N/A

SOLENOID VALVE ASSEMBLY

Part Number	Model 92A (1993 Production) 16441 (24-Volt)
Part Number	Model 760A (1993 Production) N/A (24-Volt)
Part Number	Model 760A (1994 Production) N/A (12-Volt)
Part Number	Model 765 (1993 Production) N/A (24-Volt)

VALVE AND INJECTOR CLEARANCES

VALVE CLEARANCES (8V-92)

Exhaust Valve Setting Dimension	0.016 inches (0.410 mm)
Exhaust Valve Checking Dimension	0.015–0.017 inches (0.380–0.430 mm)

VALVE CLEARANCES (SERIES 60)

Fuel Injector Setting Dimension	3.078 inches (78.2 mm)
Fuel Injector Checking Dimension	3.068–3.088 inches (77.95–78.45 mm)
Intake Valve Setting Dimension	0.008 inches (0.203 mm)
Intake Valve Checking Dimension	0.006–0.010 inches (0.152–0.254 mm)
Exhaust Valve Setting Dimension	0.026 inches (0.660 mm)
Exhaust Valve Checking Dimension	0.024–0.028 inches (0.610–0.711 mm)

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 9

FUEL SYSTEM

This section consists of three primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The three primary subsections are:

A - Fuel System
B - Accelerator Pedal
C - Air Cleaner - Dry Type

SECTION 9A

FUEL SYSTEM

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 9A-1
Components 9A-1
Operation 9A-1
Maintenance 9A-5
Troubleshooting 9A-9
Specifications 9A-9
Service Tools 9A-10

GENERAL DESCRIPTION

The coach fuel system is a close loop, continuous flow, suction type fuel delivery system. The system features a standard 182 gallon (95% capacity) welded aluminum tank, and an optional auxiliary fuel tank. Fuel filling is performed at the RH side of coach through the fuel filler door. Two different types of filler necks (Standard and Dry Break) are available on the fuel tank.

The Emco Wheaton "Posi-Loc 105" dry break fueling system provides for safe and efficient fueling of the coach. The system allows for unattended fueling without worry of fuel spills through special coupling devices mounted on the fuel tank and on the fuel island nozzle. This filler neck is designed to assure a leak-free connection and a "dry-break" disconnect. The fueling nozzle is designed to connect and lock into the filler neck adapter. It automatically stops fuel flow by sensing the back pressure created during filling and triggering the shut off mechanism.

COMPONENTS

BASIC FUEL SYSTEM

The basic fuel system consists of a fuel tank with standard filler nozzle and whistle device, fuel lines, filter, strainer, pump, fuel manifolds (integral in cylinder heads), fuel pipes (inlet and outlet), and injectors (Figure 1). For further information on the basic engine fuel system components, consult the appropriate Detroit Diesel Engine Service Manual.

DRY BREAK SYSTEM

Filler Neck Assembly

The system consists of an filler neck assembly mounted on the fuel tank. The inlet neck assembly incorporates a 3 psi pressure relief valve, basic overflow level control valve with whistle and filler neck adapter assembly with poppet valve adapter and dust cap.

Fueling Nozzle

The system consists of a fueling nozzle assembly located at the fuel island. The nozzle assembly incorporates a manually operated poppet actuation lever, fueling trigger with notch latching device and adapter locking lugs.

NOTE: The filling nozzle is not supplied with the coach. Service and maintenance information on the nozzle can be obtained from the vendor.

OPERATION

The engine fuel pump draws fuel from the tank located adjacent to battery compartment. Fuel flows through the primary fuel filter/strainer into the pump and out through the final fuel filter/strainer. The fuel then flows through the metering device controlled by the engine electronic ECM and out into the fuel manifold to each cylinder's injector. Constant pressure from the fuel pump and a restrictor at the return fitting of the fuel manifold assures that all injectors are filled. Fuel flows out of the restrictor device and to the return tube of the fuel tank.

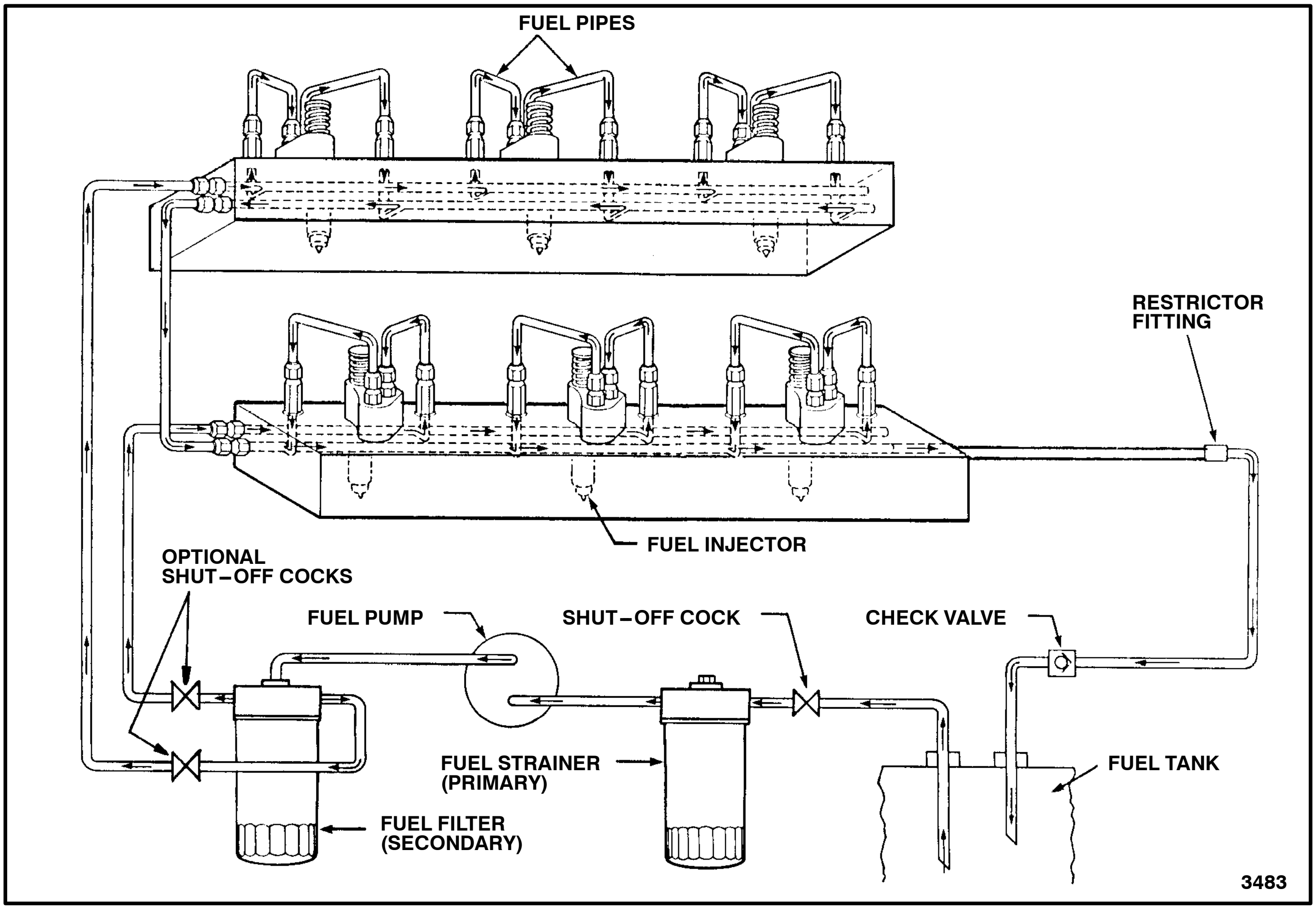
FUEL PIPES
RESTRICTOR FITTING
FUEL INJECTOR
OPTIONAL SHUT-OFF COCKS
FUEL PUMP
SHUT-OFF COCK
CHECK VALVE
FUEL STRAINER (PRIMARY)
FUEL TANK
FUEL FILTER (SECONDARY)
3483

Figure 1. Fuel System

FUELING

The standard fuel tank is fitted with the basic filler nozzle assembly with the open style nozzle filler neck. The fuel fill nozzle is inserted into the filler neck and fueling can begin. When the tank is approximately 95% full the whistle attachment should signal that fueling is complete.

When the fuel nozzle of the dry break system is inserted into the filler neck adapter and rotated clockwise 30 degrees to the locked position. Fueling may begin when the operator opens the poppet lever of the fuel nozzle, and pulls and latches the trigger mechanism which allows fuel to flow through the nozzle (Figure 2).

With nozzle open, fuel enters the tank at 20 to 50 GPM. As the tank fills, displaced air activates the whistle device. When the tank is 95% the level control valve closes and the slight back pressure of approximately 1.1 to 1.5 psi. causes the fuel nozzle trigger to trip and stop fuel flow.

The fueling nozzle's poppet lever can now be rotated up to allow the nozzle to be disconnected from the filler neck adapter. The pressure relief valve equalizes the tank pressure. Replace dust cap onto filler neck.

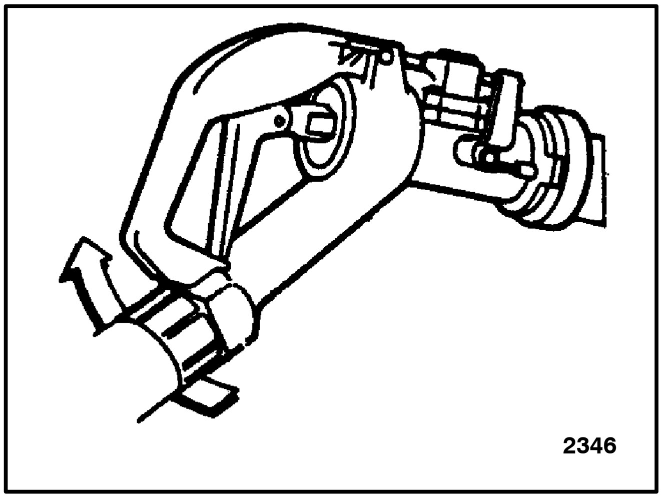

Figure 2. Engaging Nozzle

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Application	General Fuel Classification	Final Boiling Point	Cetane Number	Sulfur Content	Cloud Point
All Applications	Winter No. 1-D	675°F 357°C	45	0.50	SEE
	Summer No. 2-D	675°F 357°C	40	0.50	NOTES

Figure 3. Fuel Oil Selection Chart

DIESEL FUEL

The quality of fuel oil used for high-speed diesel engine operation is a very important factor in obtaining satisfactory engine performance, long engine life, and acceptable exhaust emission levels.

Detroit Diesel designs, develops and manufactures commercial diesel engines to operate on diesel fuels classified by the ASTM as Designation D-975 (grades 1-D and 2-D). These grades are very similar to grades DF-1, DF-2 of Federal Specifications VV-F-800.

Burner fuel (furnace oils or domestic heating fuels) generally require an open flame for satisfactory combustion. The ignition quality (Cetane rating) of burner fuel (ASTM D-396) is poor compared to diesel fuels (ASTM D-975).

In some regions fuel suppliers may distribute one fluid that is marketed as either diesel fuel (ASTM D-975) or domestic heating fuel (ASTM D-396) sometimes identified as burner, furnace or residential fuel. Under these circumstances, the fuel should be investigated to determine whether the properties conform with those indicated in the Fuel Oil Selection Chart (Figure 3).

NOTE: The cloud point should be 10ºF (6ºC) below the lowest expected fuel temperature to prevent clogging of the fuel filters by wax crystals. When prolonged idling periods or cold weather conditions below +32ºF (0ºC) are encountered, the use of lighter distillate fuels may be more practical. The same consideration must be made when operating at altitudes above 5,000 feet.

The Fuel Oil Selection Chart will also serve as a guide in the selection of the proper fuel for various applications. The fuels used must be clean, completely distilled, stable, and noncorrosive. Distillation range, cetane number, sulfur content, and cloud point are four of the most important properties of diesel fuels that must be controlled to ensure satisfactory engine operation. Engine speed load and ambient temperature all influence diesel fuel selection with respect to distillation range and cetane number.

During cold weather engine operation, the cloud point (temperature at which wax crystals begin to form in diesel fuel) should be 10°F (6°C) below the lowest expected fuel temperature in order to prevent clogging of the fuel filters by wax crystals.

A reputable fuel oil supplier is the only one who can assure you that the fuel you receive meets the distillation end point, cetane number, sulfur content, and cloud point property limits shown in the Fuel Oil Selection Chart. The responsibility for clean fuel that meets Detroit Diesel Allison specifications lies with the fuel supplier as well as the operator.

At temperatures below 32°F (0°C) particular attention must be given to cold weather starting aids for efficient engine starting and operation.

Numerous fuels meeting the properties shown in the Fuel Oil Selection Chart may be used in the Detroit Diesel engines. Alternate fuels (some with sulfur and/or cetane limits) that have been used in Detroit Diesel engines. Among these are No. 1 and No. 2 diesel fuels, kerosene, aviation turbine (jet) fuels, and burner fuels.

Fuel selected should be completely distilled material. That is, the fuel should show at least 98% by volume recovery when subjected to ASTM D-86 distillation. Fuels marketed to meet Federal Specification VV-F-8O0 (grades DF-1 and DF-2) and ASTM Designation D-975 (grades 1-D and 2-D) meet the completely distilled criteria. The differences in properties of VV-F-800 and ASTM D-975 fuels can be seen on the following chart (Figure 4).

Fuel oil should be clean and free of contamination. Storage tanks and stored fuel should be inspected regularly for dirt, water or water-emulsion sludge, and cleaned if contaminated. Storage instability of the fuel can lead to the formation of varnish or sludge in the tank. The presence of these contaminants from storage instability must be resolved with the fuel supplier.

Diesel Fuel Additives

Very small amounts of isopropyl alcohol (isopropanol) may be used to preclude fuel line freeze-up in winter months. No more than one pint of isopropyl alcohol should be added to 125 gallons of diesel fuel for adequate protection.

Specification or Classification Grade	VV-F-800 DF--1	ASTM D-975 1-D	VV-F-800, DF-2 North America	VV-F-800, DF-2 Other	ASTM D-975 2-D
Flash Point, min.	38°C 100°F	38°C 100°F	52°C 125°F	56°C 133°F	52°C 125°F
Carbon residue (10%) residuum), mass % max.	0.15	0.15	0.35	0.20	0.35
Water & Sediment, % by vol. max.	—	0.05	—	—	0.05
Ash, % by wt. max.	0.01	0.01	0.01	0.02	0.01
Distillation Temperature, 90% by vol. recovery,	—	—	—	—	282°C 540°F
min.	288°C 550°F	288°C 550°F	338°C 640°F	357°C 675°F	338°C 640°F
max.	330°C	—	370°C	370°C	—
End Point max.	626°F		698°F	698°F	
Viscosity					
Kinematic, cSt, min. @ 40°C	1.3	1.3	1.9	1.8 @ 20°C	1.9
Saybolt, SUS, min. @ 100°F	—	—	—	—	32.6
Kinematic, cSt, max. @40°C	2.9	2.4	4.1	9.5 @ 20°C	4.1
Saybolt, SUS, max. @ 100°F	—	34.4	—		40.1
Sulfur, mass % max.	0.50	0.50	0.50	0.70	0.50
Cetane No. min.	45	40	45	45	40

Figure 4. Federal Specifications and ASTM Diesel Fuel Properties

⚠ WARNING ⚠

Commercially marketed diesahol, gasahol or gasoline should never be added to diesel fuel. An explosion and fire hazard will exist if these blends are mixed and/or burned.

MCI does not recommend or support the use of any supplementary fuel additives. These include all products marketed as fuel conditioners, smoke suppressants, masking agents, deodorants, and tune-up compounds.

⚠ CAUTION ⚠

MCI does not recommend the use of drained lubricating oil in diesel fuel. Furthermore, Detroit Diesel will not be responsible for any detrimental effects which it determines resulted from this practice.

NOTE: Detroit Diesel recommends the use of No. 2-D diesel fuel in all normal applications; however, No. 1-D is acceptable.

NOTE: MCI warranty applicable to Detroit Diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer's fuel recommendations may not be within the coverage of the warranty.

Fuel Sulfur

The sulfur content of the fuel should be as low as possible to avoid premature wear, excessive deposit formation, and minimize the sulfur dioxide exhausted into the atmosphere. Limited amounts can be tolerated, but the amount of sulfur in the fuel and engine operating conditions can influence corrosion and deposit formation.

All diesel fuels contain a certain amount of sulfur. Too high a sulfur content results in excessive cylinder wear. For most satisfactory engine life, fuels containing less than 0.5% sulfur should be used. The detrimental effect of burning high sulfur fuel is reflected in Detroit Diesel lube oil change interval recommendations. Detroit Diesel recommends that the Total Base Number (TBN-ASTM D-664) of the lube oil be monitored frequently and that the oil drain interval possibly be reduced. Consult the Fuel Oil Selection Chart.

Distillation End Point

Fuel can be burned in an engine only after it has been vaporized. The temperature at which fuel is completely vaporized is described as the distillation end point (ASTM D-86). The distillation (boiling) range of diesel fuels should be low enough to permit complete vaporization at combustion chamber temperatures.

Combustion chamber temperature depends on ambient temperature, engine speed, and load. Poor vaporization is more apt to occur during severely cold weather, prolonged engine idling and light load operation. Therefore, engines will show better performance operating under these conditions when lower distillation end point fuels are used. Consult the Fuel Oil Selection Chart (Figure 3).

Ignition Quality (Cetane Number)

There is a delay between the time the fuel is injected into the cylinder and the time that ignition occurs. The duration of this delay is expressed in terms of cetane number (rating). Rapidly ignited fuels have high cetane numbers (50 or above). Slowly ignited fuels have low cetane numbers (40 or below). The lower the ambient temperature, the greater the need for a high cetane fuel that will ignite rapidly.

Difficult starting may be experienced if the cetane number of the fuel is too low. Furthermore, engine knock and puffs of white smoke may be experienced during engine warm-up especially in severely cold weather when operating with a low cetane fuel. If this condition is allowed to continue for a prolonged period, harmful deposits will accumulate within the combustion chamber. Consult the Fuel Oil Selection Chart (Figure 4).

Proposed ASTM D-975, Grade 3-D

MCI does not recommend the use of proposed grade 3-D diesel fuel in any of its engines. This grade of fuel was proposed, but not accepted by the ASTM.

The grade 3-D which was proposed is undesirable in that it possesses poor ignition quality (i.e. lower cetane); allows greater sulfur content (up to 0.7% by weight); allows the formation of more carbon deposits (Conradson carbon residue); and allows the blending of heavier, more viscous boiling point fractions that are difficult to burn. The latter tend to increase combustion chamber deposits. This type of fuel usually manifests poor cold weather properties (wax formation tendencies). In addition, the poor ignition quality adversely affects noise and emission levels.

MAINTENANCE

FUEL SYSTEM PRIMING

There can be a problem restarting an engine after it has run out of fuel. After the fuel is exhausted from the tank, it is pumped from the primary filter and sometimes partially removed from the secondary filter before the fuel supply is insufficient to sustain engine firing. The primary filter and secondary filter must be free of air in order for the system to provide adequate fuel for the injectors.

When the engine runs out of fuel, the following procedures must be performed before restarting.

1. Turn battery disconnect switch to “OFF” position.
2. Fill the fuel tank by adding a minimum of 10 gallons (38 liters) of fuel.
3. Purge the system by disconnect the line from the fuel pump to the inlet of the secondary filter, then apply fuel under pressure (60-80 psi 413-552 kPa).

NOTE: If the entire system is to be purged of air as well, allow fuel to flow freely from the fuel return line until a solid stream without air bubbles is observed.

4. Reconnect the fuel line, start the engine and check for leaks.

NOTE: It may be necessary to remove a valve rocker cover and loosen a fuel pipe nut in order to bleed any trapped air from the fuel system. Ensure that the fuel pipe is retightened before installing the rocker cover.

FUEL FLOW CHECK

A fuel flow check may be made by disconnecting the flexible fuel return line from the fitting at the rear bulkhead. Place the end of the return line in a convenient receptacle. As fuel must pass through the return line restriction fitting, do not disconnect the line at the bracket on top of the engine.

1. For non-turbocharged engines, start and run the engine at 1200 RPM. A fuel flow of 0.8 gallons (3 liters) per minute is specified with a fuel line restriction fitting having an 0.080-inch (0.203 mm) spill orifice.
2. For turbocharged engines, start and run the engine at 1800 RPM. A fuel flow of 1.4 gallons (5.3 liters) per minute is specified with a fuel line restriction fitting having a 0.070-inch (1.78 mm) spill orifice.
3. Dip the end of the return line into the fuel container. Air bubbles rising to the surface indicates that air is being drawn into the fuel system on the suction side of the fuel pump. If air is present, tighten all fuel line connections between fuel tank and fuel pump.

If fuel flow is insufficient for satisfactory engine performance, check for faulty fuel lines, clogged filters or malfunctioning fuel pump.

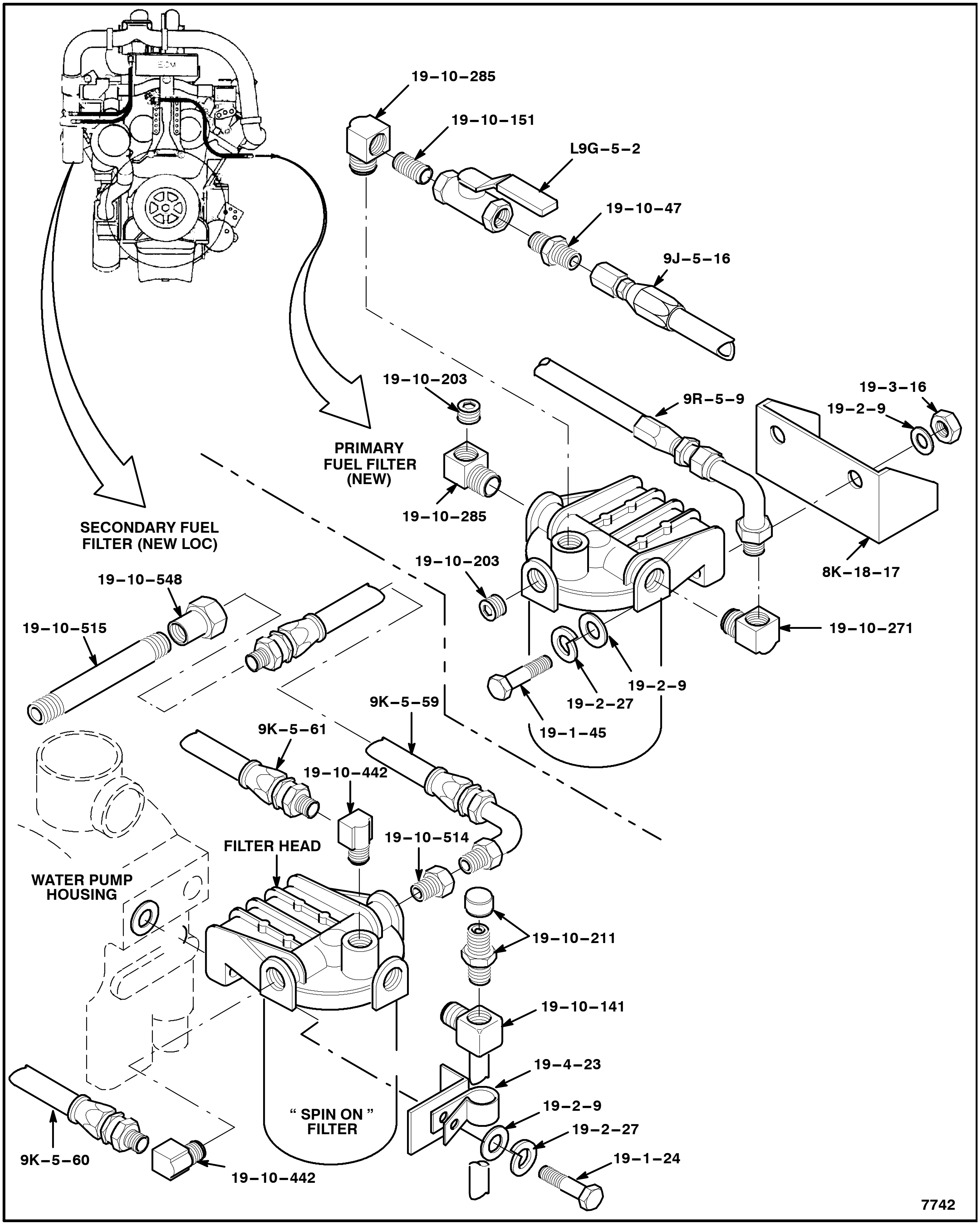

19−10−285
19−10−151
L9G−5−2
19−10−47
9J−5−16
19−10−203
PRIMARY FUEL FILTER (NEW)
19−10−285
9R−5−9
19−3−16
19−2−9
8K−18−17
SECONDARY FUEL FILTER (NEW LOC)
19−10−203
19−10−548
19−10−515
19−10−271
19−2−9
19−2−27
19−1−45
9K−5−59
9K−5−61
19−10−442
19−10−514
FILTER HEAD
WATER PUMP HOUSING
19−10−211
19−10−141
19−4−23
19−2−9
19−2−27
19−1−24
" SPIN ON " FILTER
9K−5−60
19−10−442
ECM
7742

Figure 5. Primary and Secondary Filter Components

FUEL TANK REMOVAL

A welded aluminum fuel tank is mounted in front of the rear baggage compartment. Fueling is performed through a spring return door in the body panel. Provisions are made in the body paneling for access to the fuel tank should removal be necessary.

1. Prior to removal, the fuel tanks should be completely drained. Remove the exterior fuel tank door and the bar that secures the fuel tank in place.

2. Disconnect the feed and return fuel lines. If the coach is equipped with a fuel gauge, disconnect the wire leading to the sender.

3. Ensure that the filler neck is clear, then carefully slide the fuel tank out of the compartment.

NOTE: On coaches without an auxiliary fuel tank, it will be necessary to raise the tank approximately 1/2 inch (12 mm) to allow the closing plate to clear the cutout in the floor.

FUEL FILTER (STRAINER) REPLACEMENT

The fuel system is equipped with a primary filter that is sometimes referred to as the strainer and a secondary fuel filter. The primary filter removes the larger sized debris which may be in the fuel before the fuel passes into the fuel pump. The secondary fuel filter removes the fine particles of solid matter that have passed through the primary filter, preventing such material from entering the engine injectors.

Every 10,000 miles (16,000 km), change the fuel filters, and open the drain at the bottom of the fuel tank to drain off any water or sediment.

NOTE: The service interval at which the strainer and filter should be changed is determined by operating conditions and cleanness of fuel used.

1. Turn battery disconnect switch to “OFF” position.

2. Before removing the fuel filter or strainer, close the shut-off cock which is installed at the primary filter inlet port (Figure 5).

NOTE: Valves are installed to prevent fuel from syphoning out of tank while the filters are being serviced. An optional shut-off cock also prevents the fuel pump from emptying and losing its prime.

3. Remove filter by turning counterclockwise. Replace with new filter and tighten 2/3 of a turn after contacting gasket. New gaskets should be used with each replacement.

4. Return all valves to the open position, restart engine and check for any leakage.

DRY BREAK SYSTEM

Level Control Valve

Proper functioning of the level control valve (Figure 6) is critical. A malfunctioning valve can cause the system to underfill or overfill. On a regular basis, visibly inspect for cracks in the housing, leaks around the flange gasket, or obstructions in the body housing. Remove any obstructions and replace gaskets as necessary. If the housing is cracked, the unit should be replaced. When replacing the valve, a new gasket should also be installed. When installing new gasket, it must be located so that the bleed valve is in the center of the slot.

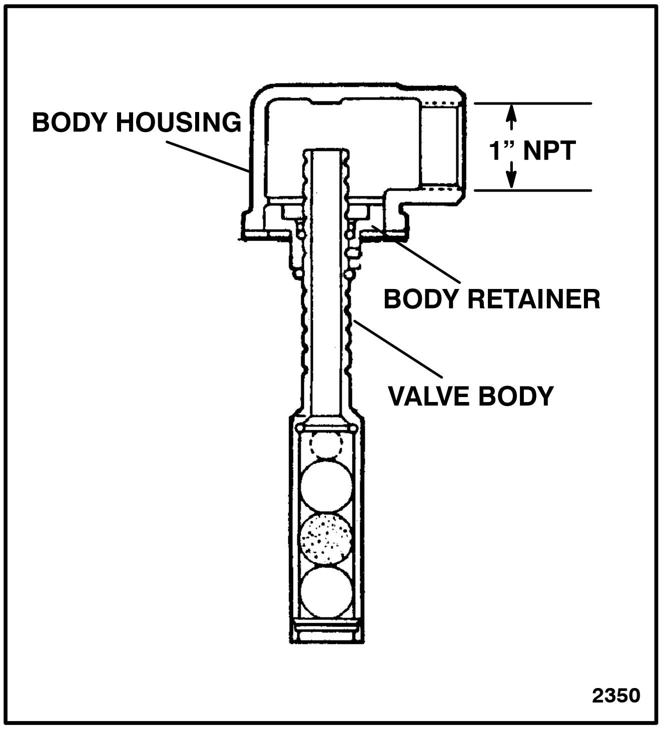


Figure 6. Level Control Valve

Whistle

The whistle screws into the outlet of the control valve (Figure 7). the whistle is not functioning properly, refueling operations could be hindered. On a regular basis, the whistle should be inspected for obstructions or cracks in the housing. Clean any obstruction from the unit as required. If the body is cracked, replace the whole unit.

To replace the whistle, simply unscrew the faulty whistle and replace it with a new one. Hand tightening is all that is necessary. Do not overtighten.

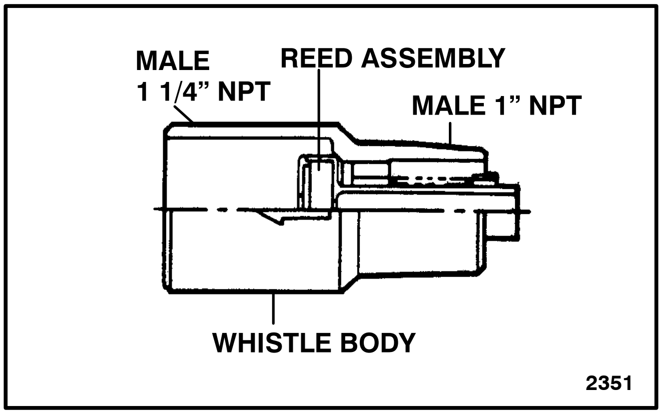

MALE
1 1/4” NPT
REED ASSEMBLY
MALE 1” NPT
WHISTLE BODY
2351

Figure 7. Fuel Filling Monitor Whistle

Pressure Relief Valve

The pressure relief valve relieves any excess pressure in the fuel tank over 3 psi. This eliminates any chance of tank rupture, making preventive maintenance highly important (Figure 8).

Frequently inspect the pressure relief valve for any cracks in the housing, leaks around the flange gasket, or obstructions. Remove any obstructions, and replace leaking gaskets. Do not attempt to repair a malfunctioning pressure relief valve; replace it.

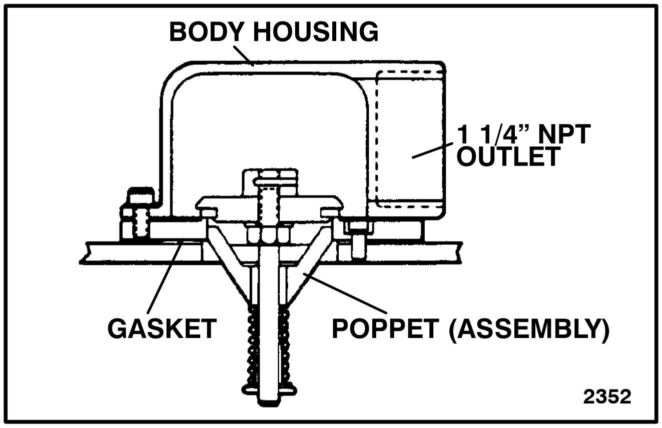

BODY HOUSING
1 1/4” NPT
OUTLET
GASKET
POPPET (ASSEMBLY)
2352

Figure 8. Pressure Relief Valve

Filler Neck Adapter

The adapter (Figure 9) ensures a leak-free connection and a dry-break disconnect.

Routinely inspect the adapter for a secure flange seal and tighten or replace as necessary. If a leak around the poppet is evident, see repair procedures below. Replace the poppet if chipped or cracked.

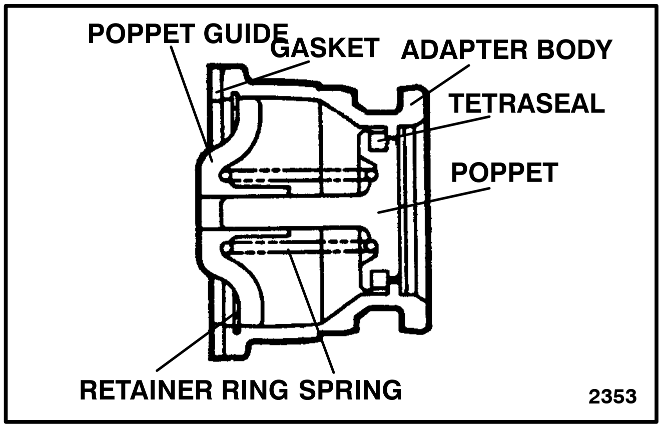

POPPET GUIDE
GASKET
ADAPTER BODY
TETRASEAL
POPPET
RETAINER RING
SPRING
2353

Figure 9. Filler Neck Adapter

No special tools are necessary. To replace the flange gasket, simply unbolt the adapter from the filler neck, replace the gasket, and secure the bolts. to replace the poppet or tetraseal:

1. Unbolt adapter.
2. Remove retainer ring.
3. Remove poppet assembly.
4. Install new tetraseal.
5. Install new poppet.
6. Reassemble in reverse order of disassembly.

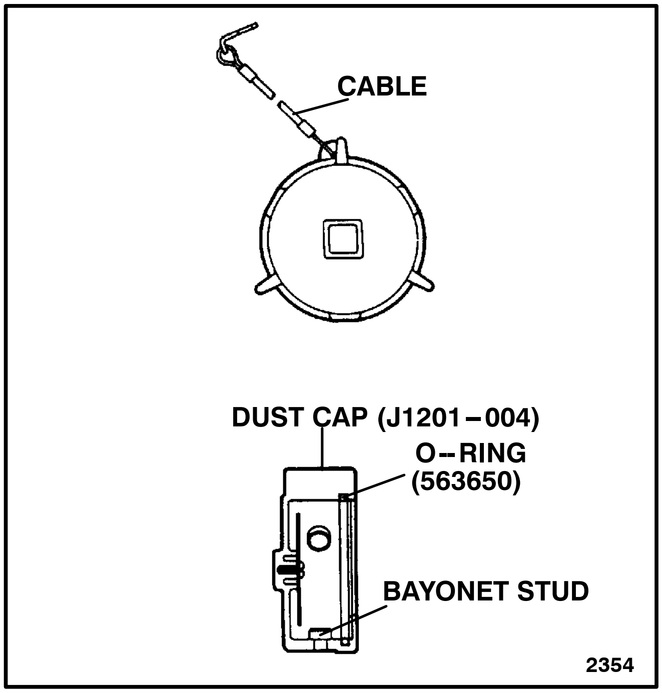

CABLE
DUST CAP (J1201−004)
O−RING
(563650)
BAYONET STUD
2354

Figure 10. Filler Neck Adapter Dust Cap

When not refueling, the aluminum dust cap protects the adapter (Figure 10). An O-ring seals the adapter opening. Replace the entire dust cap if cracks are detected, or if the bayonet studs are broken or bent. Inspect dust cap O-ring for nicks or cuts; replace damaged or worn O-ring.

TROUBLESHOOTING

Problem	Possible Cause
Nozzle Will Not Shut Off.	1. Flow below minimum rate of 20 GPM. 2. Float valve stem bent. 3. Float missing or not fastened by cotter pin. 4. Adapter flange bolts loose. 5. Nozzle malfunction - return to factory for rebuilt exchange nozzle. 6. Float valve disc damaged - remove float valve assembly, invert and pour fuel on valve disc - should slowly leak through. Replace with new float if defective.
Fuel Oil Blowback When Nozzle Disconnected	1. Operator has pulled disconnect handle and rotated nozzle off adapter before tank has vented. 2. Lock pin bent - operator tried to remove nozzle without pulling disconnect handle. 3. No pressure equalization hole in tank portion of filler neck. 4. Roll over ball check not level. 5. Tank has been topped off and filler neck is full of fuel under pressure.

SPECIFICATIONS

FUEL TANK & FILLER NOZZLE ASSEMBLY

Manufacturer	MCI
Part Number (Basic Tank)	9L-6-108
Part Number (Auxiliary Tank)	9F-6-207
Capacity @ 95% (Main Tank)	182 U.S. gals. (688 liters)
Capacity @ 95% (Auxiliary Tank)	34 U.S. gals. (128 liters)
Part Number (Fill Nozzle Basic)	9L-6-143
Part Number (Fill Nozzle W/Dry Break)	9L-6-124

FUEL FILTER ASSEMBLY (6V-92 & 8V-92 SERIES)

Part Number (Primary)	25010776 (A/C #T-915)
Part Number (Secondary)	25010778 (A/C #T-916)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

FUEL FILTER ASSEMBLY (SERIES 60)

Part Number (Primary)	25011910 (A/C #TP-1057)
Part Number (Secondary)	25014342 (A/C #TP-916D)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

FUEL FILTER ASSEMBLY (CUMMINS M-11)

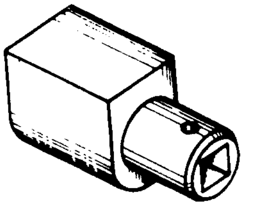
Part Number (Primary)	3315843 (FS1212 Fleetgard)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

FUEL FILTER ASSEMBLY (CATERPILLAR)

Part Number (Primary)	1R0712
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE FACILITY.



20−33 Socket -- Tightening Fuel Line Fittings

SECTION 9B

ACCELERATOR PEDAL

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 9B-1
Components 9B-1
Operation 9B-1
Maintenance 9B-1
Specifications 9B-2

GENERAL DESCRIPTION

The D series coaches use an electronic accelerator pedal assembly. The accelerator pedal's electronic throttle is an integral part of the engine electronic control system, and referred to as a throttle position sensor (TPS). The accelerator pedal assembly is mounted onto the brake pedal assembly's mounting plate (Figure 1).

COMPONENTS

The accelerator pedal consists of an electronic throttle assembly with mounting and MCI foot pedal with rubber tread. The pedal assembly is secured to the brake pedal mounting plate with machine screws. Throttles incorporate a spring returned roller actuator mechanism, a throttle position sensor (potentiometer) and interconnecting harness with floor plate.

NOTE: The throttle assemblies are reworked to add the MCI foot pedal and rubber tread onto the throttle pedal.

OPERATION

This electronic accelerator is used with all electronically controlled engine installations. As the pedal is pressed down, the throttle's roller and actuator lever rotate the potentiometer. The relative position of the potentiometer determines the signal which is transmitted to the ECM, which interprets the information and either increases or decreases engine RPM.

NOTE: Because of the different signal requirements for specific ECM's, different engine installations will require specific throttle assemblies. Some throttle assemblies will include an idle validation sensor and additional harness.

MAINTENANCE

The pedal mechanism is sealed and does not require any lubrication. The pedal assembly and the area around the throttle's roller mechanism should be keep clean of dirt and other foreign matter. Inspect pedal assembly every 50,000 miles (80,000 km) for excessive wear or damage.

CAUTION

MCI recommends the replacement of the throttle as an assembly. The throttle's potentiometer and the spring roller actuator are serviceable items, however, calibration of the pedal may be required after repairs have been made.

REMOVAL

1. Place battery disconnect switch to "OFF" position.
2. Disconnect pedal harness from interconnecting DDEC harness.
3. Remove harness connector and pull pigtail up through floorboard.
4. Unfasten pedal mounting screws and remove from brake pedal mounting plate.
5. Remove foot pedal rubber tread and unfasten pedal mounting screws from throttle pedal.

INSTALLATION

1. Reinstall in reverse order of "Removal" procedure.

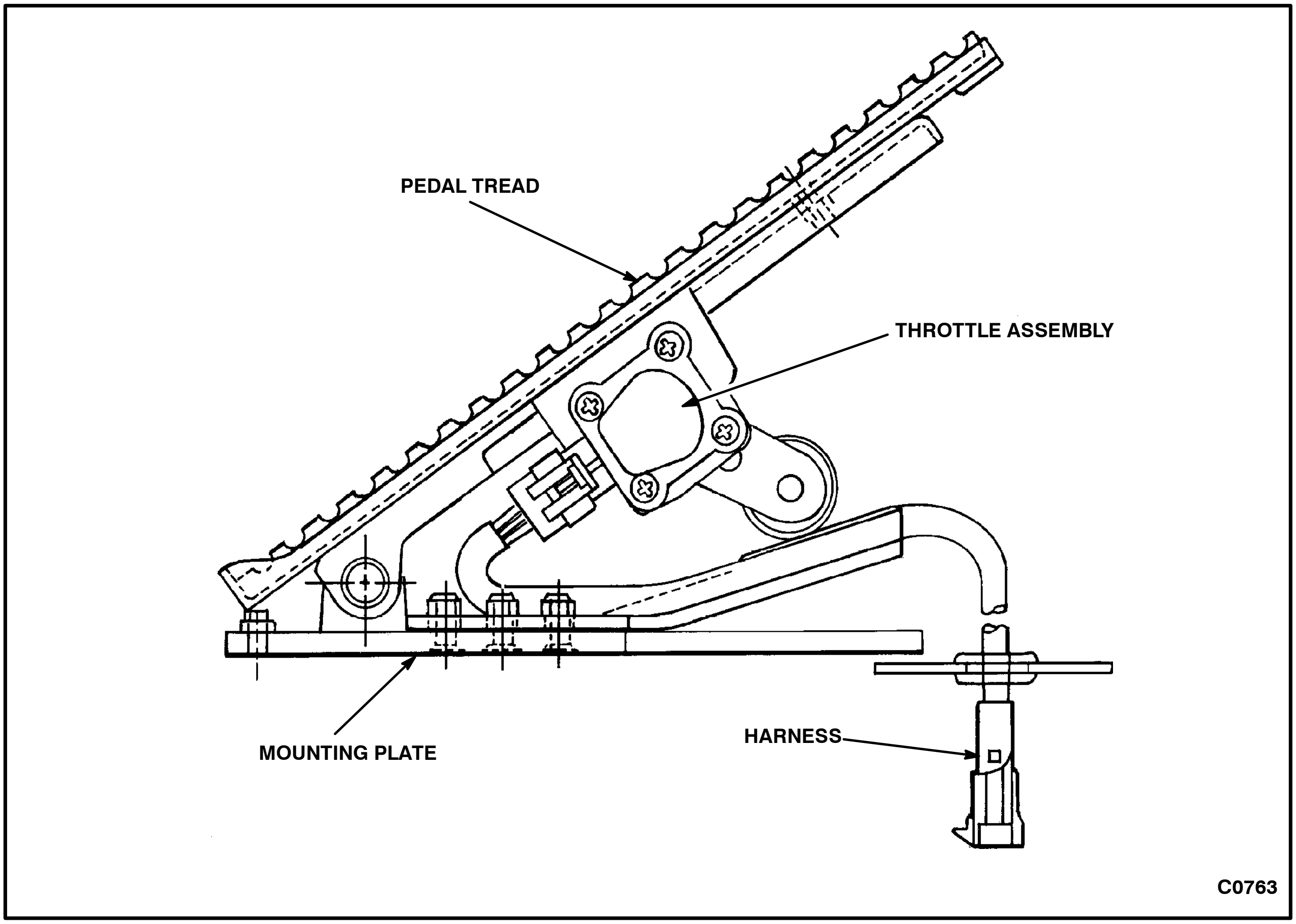


Figure 1. Electronic Accelerator Pedal

SPECIFICATIONS

ACCELERATOR THROTTLE ASSEMBLY

Part Number (1993/94 Detroit Diesel DDEC II & III Engine Installations W/Bendix)	4L-15-61
Part Number (1993/94 Detroit Diesel Series 60 Engine Installation W/Williams)	4L-15-104
Part Number (1995 Detroit Diesel DDEC III Engine Installation W/Williams Light Pedal)	4L-15-119
Part Number (1993/94 Cummins CELECT Engine Installations)	9L-4-72
Part Number (1995 Cummins CELECT Engine Installations)	9L-4-118
Part Number (1993 Caterpillar PEEC Engine Installations)	9L-4-70
Part Number (1994 Caterpillar PEEC Engine Installations)	9L-4-76
Part Number (1995 Caterpillar PEEC Engine Installations)	9L-4-117

FOOT PEDAL

Manufacturer	MCI
Part Number (DDEC II & III Engine Installations W/Bendix Throttle)	4L-15-78
Part Number (DDEC III, Cat & Cummins Engine Installations W/Williams Throttle)	4L-15-79

SECTION 9C

AIR CLEANER - DRY TYPE

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	9C-1

GENERAL DESCRIPTION

The coaches are equipped with a single dry-type replaceable element air cleaner, located in the engine compartment at the rear of the coach on the left-hand side. (Figure 1.) Access to the air cleaner is through the left-hand tail light door.

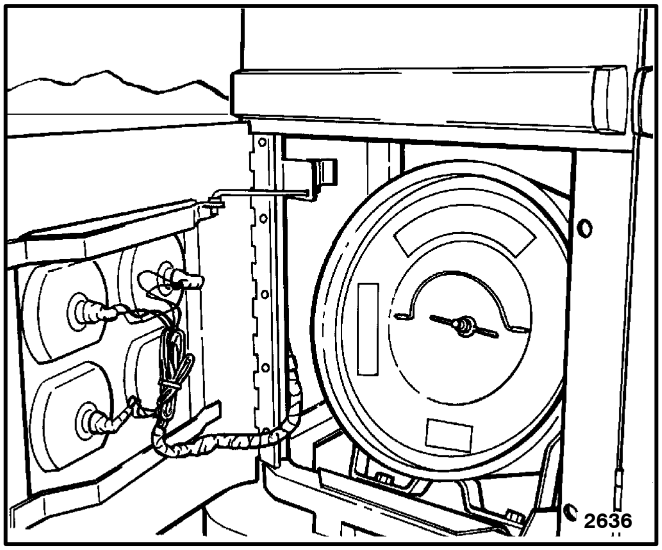


Figure 1. Air Cleaner Assembly

Engine air enters the air cleaner through intake ducts and all foreign matter, dust and dirt is prevented from entering the engine by the pre-filter and filter element. The dirt particles will collect in the element assembly. Any moisture collected in the assembly will drain out through the bottom of the cleaner.

A resettable restriction indicator is installed near the air cleaner to inform the operator of the filter condition. The indicator is connected to the outlet side of the air cleaner and measures air flow restriction in inches of water.

When the indicator service window reaches the red zone, the filter element should be replaced and the indicator reset (Figure 2).

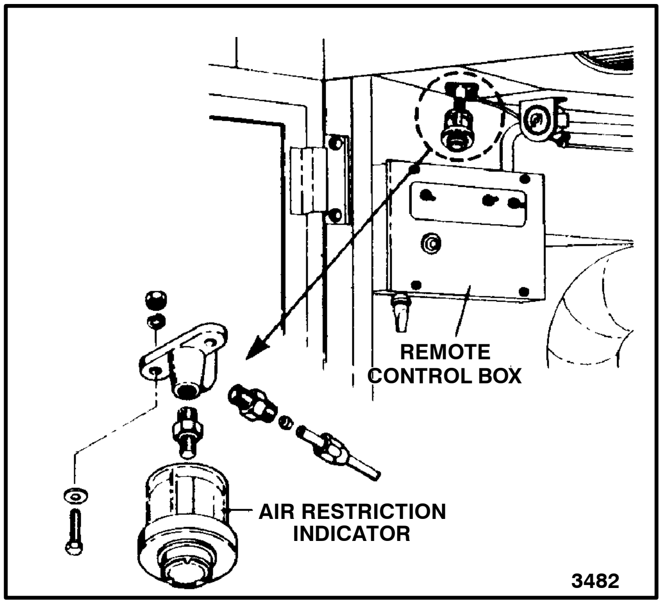


Figure 2. Restriction Indicator

By monitoring the restriction indicator, maximum filter element service can be achieved and at the same time provide protection to the engine and maintain fuel system efficiency.

To service the air cleaner:

1. Stop the engine.
2. Loosen the wingnut securing the air cleaner element to the air cleaner.
3. Remove the element.

NOTE: Remove any dust from the interior of the air cleaner body with a damp cloth before reinstalling a clean element.

Proper inspection prolongs engine and air cleaner service life. The air cleaner and air induction system should be inspected each time the engine oil is changed. It is not necessary to disassemble the air cleaner for inspection.

4. Check air cleaner body for cracks, loose nuts and bolts.

5. Check clamps on air induction system to determine if they are loose, broken or missing.

6. Replace, repair, or correct any improper situations.

7. Inspect the gasket sealing surface inside the air cleaner. It must be smooth, flat and clean.

8. Install the air cleaner element. Be certain element seals securely.

9. Inspect element cover gasket and replace if necessary.

INSTALLATION

Whenever it becomes necessary to remove the air cleaner assembly (dry type) care should be taken when reinstalling the air cleaner. The pre-filter should be mounted snugly into the air intake box and clamped tightly to the air cleaner inlet to prevent entry of dust into the air cleaner.

⚠ CAUTION ⚠

A. Never operate the vehicle without an element in the air filter assembly.

B. Use only original equipment filter elements.

C. Whenever element has been removed from filter body, clean inside of filter body with a clean, damp cloth.

D. Do not ignore the warning given by the air restriction indicator. To do so is to invite serious engine damage.

E. Store new elements in a protected area free from dust and damage.

F. Use the proper element when replacing element in filter.

G. Dirty elements should not be washed or reused.

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 10

LUBRICATION

SECTION 10

LUBRICATION

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 10-1
Components 10-1
Maintenance 10-3
Specifications 10-14

GENERAL DESCRIPTION

This section will discuss the specific lubrication requirements for most of the coach components. Several different schedules are provided in this section for reference, however, intervals specified may not be appropriate for all applications. The “LUBRICATION SCHEDULE” is provided as a minimum requirements guide for most lubricated components. A location key chart is included to give approximate location of service points. Where cleaning, removal or disassembly are required for lubrication purposes, procedures will be found in the applicable sections of this maintenance manual.

A “PREVENTIVE MAINTENANCE SCHEDULE” is also included at the end of this section. It includes most lubrication, cleaning and inspection intervals required for coach components.

High lube maintenance items such as engine crankcase oil, transmission fluid, and other components shown in the “INSPECTION SCHEDULE” should be checked daily or before the start of each run. Add oil as needed to bring the level to the “Full” mark on the dipstick.

COMPONENTS

FILL TUBES

Engine crankcase oil is introduced into the engine through the oil fill tube located at the left side or the front gear case on Series 60, Caterpillar and Cummins engine installation. The oil fill tube is located on the right side front valve cover for 8V-92 engine installations. The power steering reservoir fill tubes are located on the reservoir, or at the upper RH side of engine. Oil fill tubes are fitted with spring caps, twist caps or rubber plugs.

NOTE: Transmission lube oils are introduced through their respective dipstick tubes or side fill plugs on transmission body. Effective with unit 47701 dipstick filler tubes will no longer be installed on manual transmissions.

DIPSTICKS

The dipstick is used to assure proper lube levels in the engine and transmission oil pans. The dipstick assembly is located at the lower left side of Caterpillar and Cummins installations, and upper right side of 8V-92 and Series 60 installations. Dipsticks for automatic transmissions are located inside the RH rear side service door, while the manual transmission dipstick is located inside the LH rear side service door.

NOTE: B500 transmission installations have an electronic fluid level monitoring system, however, checking of oil levels via the manual dipstick inspection method is recommended.

HOSES

The coach lube oil hoses are constructed of either elastomer tube with inner steel braiding or Teflon lined outer stainless braided. The performance of the engine and auxiliary equipment is greatly dependent on the ability of flexible hoses to transfer lubricating oils. Maintenance of hoses is an important step to ensure efficient, economical and safe operation of the engine and related equipment.

POWER STEERING RESERVOIR

The power steering fluid reservoir is equipped with a cartridge filter and sight gauge to facilitate checking of the oil level. The reservoir is located at the top front on the Series 60 installations, and at the rear on the 8V-92, Caterpillar and Cummins installations. Adding fluid to the reservoir is accomplished through the reservoir's fill tube.

OIL RESERVE TANK

A two-gallon (7.6 L) oil reserve tank is available as optional equipment. It is connected to the crankcase by a hose with a shut-off valve. The reserve tank allows oil to be added to crankcase by manually opening the valve. Comparison of oil levels in the sight gauge, before and after adding oil to the crankcase, shows how much oil was added (Figure 1).

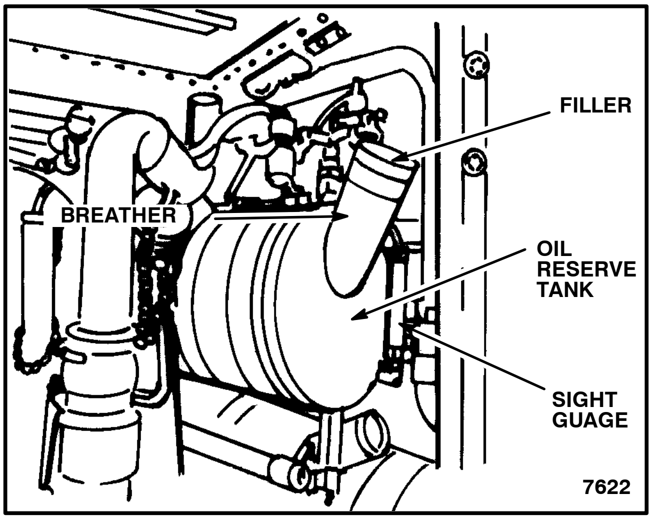


Figure 1. Oil Reserve Tank

FILTERS

Coach engine installations use a two-element oil filtration system. Allison B500 installations use a two-element internal oil filtration system, while the HT-700 series transmissions use a single external filter in combination with a sump pick-up screen. Most filters are of the screw-on type, but some cartridge types are also used.

Optional engine oil bypass filter arrangements may be added to allow for emergency filtering capacity. Other types of filtration arrangements (approved by the engine manufacturer) may also be used to remove contaminants from the lubricating oil.

NOTE: It is recommended that each time the oil is changed, a new oil filter element should be installed.

Several different types of air filters are also used on the coach. Air filters can be found in the engine air intake system, solenoid water valves and in-line screen filters of the suspension system.

LUBRICATING OILS & GREASE

Heavy-Duty Engine Oil

The 8V-92 engines use SAE 40 grade heavy-duty engine oil, while the Series 60, Caterpillar and Cummins engines use SAE 15W-40 grade heavy-duty engine oil exclusively. Satisfactory and prolonged engine operation requires heavy-duty lubricating oils with specialized additives for diesel engines. These oils provide better lubrication, have more heat resistance and counteract sludge formation more effectively than the straight mineral type oils. Refer to Section 8 of this manual for detailed oil specifications.

NOTE: The coach power steering system utilizes heavy-duty engine oil.

Multi-Purpose Gear Oil

The manual transmissions use multi-purpose gear oils or mineral oils with viscosities adjusted for temperature ranges in which the coach is operated. Generally an SAE 85W-140 to 85W-90 grade oil is suitable. The auto-shift manual transmissions use a synthetic gear oil (CD50 or equal).

The axles use multi-purpose gear oils or hypoid gear oils with viscosities adjusted for temperature ranges in which the coach is operated. Generally an SAE 85W-140 to 85W-80 grade oil is suitable.

The oil-lubed wheel bearing and trailing axle bearing boxes utilize multi-purpose gear oils.

Automatic Transmission Fluid

All automatic transmissions use lube oils that qualify to torque fluids specification C-4 (i.e., Dexron IIE or Dexron III). Refer to Section 13 of this manual for detailed oil specifications.

Multi-Purpose Grease

Both manual and automatic slack adjusters and camshaft bearings use a non-caking soap based multi-purpose grease (grades EP-1 or EP-2).

Drum brake cam rollers use a non-caking clay based multi-purpose grease (grade EP-1). Anchor pins and disc brake calipers use a non-caking Poly-Urea based multi-purpose grease (grade EP-1).

The grease-lubed wheel bearing and manual transmission clutch and shifting linkage assemblies also utilize multi-purpose grease.

NOTE: The air system uses a special lubricating fluid applied to the shutterstat filter assembly. The lubricant is distributed to components throughout the air system.

MAINTENANCE

HOSES

Inspection

Check hoses daily as part of the pre-startup inspection. Examine hoses for leaks, and check all fittings, clamps, and ties carefully. Ensure that hoses are not resting on or touching shafts, couplings, heated surfaces including exhaust manifolds, any sharp edges, or other obviously hazardous areas. Since all machinery vibrates and moves to a certain extent, clamps and ties can loosen and wear with age. To ensure continued proper support, inspect fasteners frequently and tighten or replace them as necessary.

Investigate leaks immediately to determine if fittings have loosened or cracked and also if hoses have ruptured or worn through. Take corrective action immediately. Leaks are not only potentially detrimental to machine operation, but can also result in added expense caused by the need to replace lost fluids.

⚠ **WARNING** ⚠

Personal injury and/or property damage may result from fire due to the leakage of flammable fluids such as fuel or lube oil.

Service Life

A hose has a limited service life, determined by the temperature and pressure of the gas or fluid within it, time in service, mounting, ambient temperatures, amount of flexing, and the vibration it is subject to. The service life of a hose may also be reduced by exposure to road salt. Some types of hoses with wire braid reinforcement are subject to oxidation damage and a subsequent reduction in hose strength.

MCI recommends that all hoses be thoroughly inspected at least every 500 operating hours and/or annually. Look for cover damage or indications of damaged, twisted, worn, crimped, brittle, cracked, or leaking lines. MCI further recommends that all hoses be replaced during major overhaul and/or after a maximum of five years service. Replacement hose assemblies should always be equal or superior to the original equipment supplied with the engine.

NOTE: Hoses having the outer cover worn through or damaged metal reinforcement should be considered unfit for service.

Review the plumbing and fasten hoses only after the engine or related machinery is installed. Extra fasteners or readjustment of an existing support may be required during the operating life of a unit. Make sure that hoses are routed and clipped properly to prevent damage from vibration, abrasion, heat, and mechanical loads. Hoses routed close to heated surfaces may have a shortened service life. Additional shields or protective sleeves may extend hose life in special applications where shortened life is anticipated or has been experienced. Consult with the hose manufacturer relative to alternate hose compositions where shields and sleeves are impractical.

NOTE: The proper installation, routing and fitting torque criteria for hoses can be obtained from major hose suppliers and manufacturers.

SERVICE INTERVALS

Oil Lubricated Components

Serviceable periods for lube oils are dependent upon several different factors. The service intervals may be gradually increased or decreased until the most practical oil change period for a particular service has been established (based on recommendations from an oil supplier's analysis of drained oil or from prolonged experience with a specific lubrication product).

ENGINE CRANKCASE OIL

The oil change intervals for engines are greatly dependent on the operating conditions of a particular coach (e.g. loads, speed, terrain etc.). The engine oil should be changed every 10,000 miles (16,000 km).

NOTE: Solvents should not be used as flushing oils in running engines. Dilution of the fresh refill oil supply can occur, which may be detrimental.

Engine oil cooler flow and oil temperature should be checked every 25,000 miles (40,000 km) to determine oil cooler efficiency. This check should be made by inserting a steel jacketed thermometer in the dipstick opening immediately after stopping a hot, loaded engine. If the oil temperature exceeds the coolant temperature by more than 60°F (33°C), the oil cooler may be clogged.

MANUAL TRANSMISSION

The manual transmission is supplied with a "factory filled" lube oil which should be drained and refilled after the initial break-in period of 3,000 miles (4,800 km), and in no case over 5,000 miles (8,000 km) of initial coach operation. Subsequent oil change intervals should take place every 50,000 miles (80,000 km) or 1,500 operating hours.

NOTE: Effective with unit 47701 dipstick/filler tubes will no longer be installed on manual transmissions.

AUTOMATIC TRANSMISSION

All automatic transmissions are supplied with a "factory filled" lube oil which should be drained and refilled after the initial break-in period of 5,000 miles (8,000 km). Subsequent oil change intervals for B500 and HD4060 transmissions should take place every 25,000 miles (40,000 km).

The HT700 series automatic transmission requires that the fluid be change every 50,000 miles (80,000 km), however, the filter must be changed every 25,000 miles (40,000 km). These transmissions are also equipped with an internal sump pick-up screen which requires servicing every 100,000 miles.

NOTE: Automatic transmissions with retarder installations may require more frequent oil changes.

DRIVE AXLE

The drive axle differential is supplied with a "factory filled" lube oil which should be drained and refilled after the initial break-in period of 2,000 miles (3,200 km), and in no case over 5,000 miles (8,000 km) of initial coach operation. Subsequent oil change intervals should take place every 100,000 miles (160,900 km) or 3000 operating hours.

NOTE: This filter should be replaced in conjunction with servicing of the reservoir filter element. The power steering system should be drained and refilled at this time.

TRAILING AXLE (PIVOTING ARM 102D3)

The trunnion arm bearing boxes should be inspected and filled with lubricant every 25,000 miles (40,000 km) or 750 operating hours. Bearing box lube oil should be changed whenever seals or bearings are serviced.

WHEEL BEARINGS (OIL LUBED)

The wheel bearing lube oil should be inspected and filled with lubricant daily. The lube oil should be drained and refilled every 100,000 miles (160,900 km) or 3000 operating hours and whenever the hub or wheel bearings are serviced.

POWER STEERING SYSTEM

The power steering system's hydraulic/lube oil should be inspected and filled with lubricant daily. The hydraulic/lube oil should be drained and refilled whenever the reservoir's filter is serviced.

AIR SYSTEM

The shutterstat filter assembly should be inspected and filled with the special air component lubrication every 10,000 miles (16,090 km), or whenever the filter/reservoir is serviced. Fill reservoir through the top hex plug.

Grease Lubricated Components

FRONT AXLE

Front axle knuckle pins and tie rod end assemblies should be greased after the first 4,000 miles (6,500 km), and every 50,000 miles (80,000 km) thereafter.

TRAILING AXLE (SELF-STEERING 102DL3)

Self-steering trailing axle knuckle pins and tie rod end assemblies should be lubricated after the first 4,000 miles (6,500 km), and every 50,000 miles (80,000 km) thereafter.

WHEEL BEARINGS (GREASED LUBED)

The wheel bearing should be lubricated every 100,000 miles (160,900 km) or 3000 operating hours and whenever the hub or wheel bearings are serviced.

CLUTCH LINKAGE

The clutch linkage lever arm and front cross-shaft bearings require lubrication every 10,000 miles (16,000 km).

NOTE: Front cross-shaft bearing lube fittings are located on support bracket inside front side service door.

CLUTCH RELEASE BEARING

The clutch release bearing and yoke shaft pivot (transmission grease fittings) should be lubricated every 10,000 miles (16,090 km) or 300 operation hours (Figure 2).

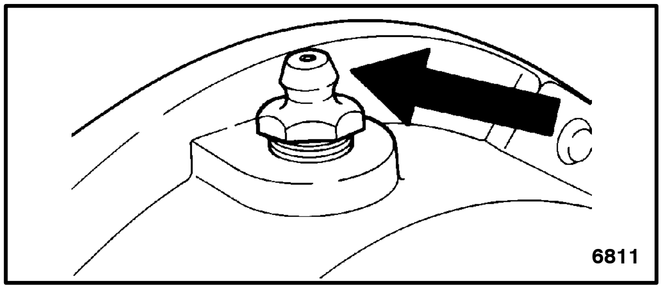


Figure 2 . Release Bearing

TRANSMISSION SHIFT LINKAGE

The transmission shift linkage front and rear control boxes require lubrication every 75,000 miles (121,000 km). The shift shaft pivots (transmission grease fittings), pivoting links and front and rear u-joint bearings should be lubricated every 10,000 miles (16,000 km).

NOTE: Front bearing lube fittings are located inside RH wheelwell. Rear fittings are located beneath the rear bogie inspection panel.

DRIVESHAFT

The driveshaft u-joint bearings and slip-joint require lubrication every 10,000 miles (16,000 km).

BRAKE ASSEMBLIES

The drum brake anchor pins and cam rollers require inspection and lubrication as required every 10,000 miles (16,000 km). Relubricate at each brake relining or service. The disc brake calipers should be inspected and lubricated at each relining interval.

SLACK ADJUSTERS

The manual and automatic slack adjusters must be lubricated every 5,000 miles (8,000 km) or when brakes are serviced.

BRAKE CHAMBER

The DD3 brake chamber lock mechanism requires lubrication every 25,000 miles (40,000 km).

BRAKE CAMSHAFT BUSHING

The camshaft bushings must be lubricated every 100,000 miles (160,000 km) or when brakes are serviced.

> **NOTE:** MCI recommends that brake component lubrication be done with a hand grease gun to insure against the over-greasing of internals or pressurizing of camshaft seals. Wipe all excess grease off internal components.

A/C COMPRESSOR

The air conditioning compressor's pivot mounting requires lubrication every 5,000 miles (8,000 km) or 150 hours of operation.

FILTER REPLACEMENT

Engine Crankcase Oil Filters

Engine oil filter should be changed every 10,000 miles (16,000 km) or whenever the crankcase oil is drained and refilled. The engine oil filters are located along the lower RH side of the engine block.

1. Turn battery disconnect switch to "OFF" position.
2. With appropriate filter removal tool, unfasten the screw-on filter elements.
3. Replace with new elements and tighten 2/3 turn passed element contact with base.
4. Start engine and check for leaks.

Transmission Filter (HT-700 Series)

The transmission filters require changing after the initial break-in period of 5,000 miles (8,000 km). Subsequent filter changes should take place every 25,000 miles (40,000 km) or 750 operating hours.

1. Turn battery disconnect switch to "OFF" position.
2. With appropriate filter removal tool, unfasten the screw-on filter element.
3. Replace with new elements and tighten 2/3 turn passed element contact with base.
4. Start engine and check for leaks.

Transmission Filter (B500)

The transmission filters require changing after the initial break-in period of 5,000 miles (8,000 km). Subsequent filter changes should take place every 25,000 miles (40,000 km) or 750 operating hours.

1. Turn battery disconnect switch to "OFF" position.
2. Remove drain plug from control module sump, and allow it to drain completely.

> **NOTE:** It is not necessary to drain fluid if only filters are to be changed.

3. Unfasten and remove the capscrews from both filter covers.
4. Remove the cover, O-ring, gasket and filter element.
5. Prelube element and install in reverse order.
6. Tighten capscrews to 38-45 ft-lbs (51-61 N·m).

Steering System In-Line Filter

The power steering in-line filter is located in the upper right side of the engine compartment. Change the filter every 75,000 miles (121,000 km). This is a pressure line spin-on type filter (Figure 3).

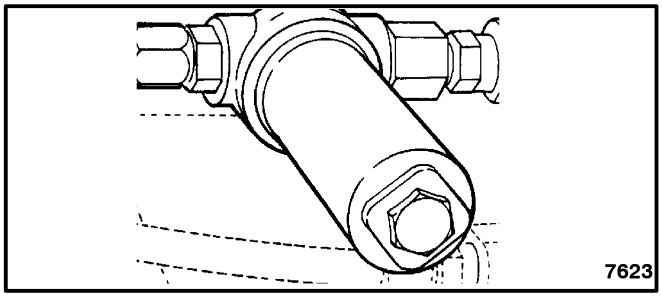
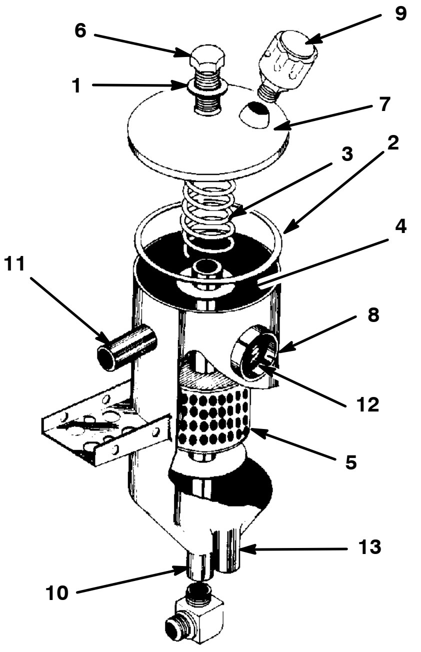


Figure 3 . In-Line Filter

1. Turn battery disconnect switch to "OFF" position.
2. Place socket on bottom hex and unfasten screw-on filter element bowl from filter head.
3. Discard and replace with new filter element.
4. Install new O-ring seal and assemble in reverse order.
5. Tighten hex bowl to 38-45 ft-lbs (51-61 N·m).
6. Start engine and check for leaks.



1. COVER BOLT GASKET
2. COVER GASKET
3. CARTRIDGE RETAINING SPRING
4. CARTRIDGE SUPPORT WASHER
5. FILTER CARTRIDGE
6. COVER BOLT
7. COVER
8. SHELL
9. BREATHER CAP
10. RESERVOIR INLET
11. FILLER INLET
12. SIGHT GLASS
13. OUTLET

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Figure 4. Power Steering Reservoir

Filter/Reservoir

The power steering reservoir filter element should be serviced at approximately 75,000 miles (121,000 km), This is a non-pressurized cartridge filter (Figure 4).

1. Turn battery disconnect switch to “OFF” position.

2. Place socket on top hex capscrew and unfasten filter cover. Remove cover, gasket, element retaining spring and support washer.

3. Remove and discard filter element and replace with new filter element.

4. Reassemble in reverse order, tighten cover capscrew to 35 ft-lbs (50 N•m).

5. Start engine and check for leaks.

Shutterstat Filter

1. Turn battery disconnect switch to “OFF” position, and drain the air system completely.

2. Unfasten capscrews, attaching top and bottom halves and remove gasket.

3. Remove filter material and replace with new material

4. Reassemble in reverse order; tighten cover capscrew to 25 in-lbs.

5. Start engine and check for leaks.

INSPECTION SCHEDULE (LUBRICATED COMPONENTS)

INSPECT DAILY - SERVICE IF REQUIRED

KEYS*	DESCRIPTION	METHOD	SPECIFICATION CODE
1	Engine Lube Oil (Series 92)	Inspect & Service	S-1
1	Engine Lube Oil (Series 60)	Inspect & Service	S-2
2	Power Steering Reservoir	Inspect & Service	S-5
3	Wheel Bearings - All (Oil Lubed)	Inspect & Service	S-11 & S-12
4	Transmission (Automatic)	Inspect & Service	S-15

INSPECT EVERY 10,000 Miles (16,000 km) - SERVICE IF REQUIRED

8	Anchor Pins & Rollers (Drum Brakes)	Inspect & Service	S-19

INSPECT EVERY 100,000 Miles (161,000 km) - SERVICE IF REQUIRED

24	A/C Compressor Oil	Inspect & Service	S-22 & S-28
3	Wheel Bearings and Seals	Inspect & Service	S-9 & S-10
12	Pivot Arm Bearings and Seals	Inspect & Service	S-9

INSPECT AT BRAKE RE-LINING - SERVICE IF REQUIRED

8	Anchor Pins & Rollers (Drum Brakes)	Inspect & Service	S-19
16	Brake Caliper (Disc Brakes)	Inspect & Service	S-19

FILTER MAINTENANCE SCHEDULE

KEYS*	DESCRIPTION	SERVICE INTERVAL	METHOD
29	Engine Oil Filter	Every 10,000 miles	Change
35	Fuel Filter	Every 10,000 miles	Change
36	Transmission Oil Filter (Initial Fill)	Every 5,000 miles	Change
36	Transmission Oil Filter (Normal Interval)	Every 25,000 miles	Change
N/A	Air Compressor Governor Air Filters	Every 25,000 miles	Inspect/Clean
30	Shutterstat Air Filter	Every 10,000 miles	Clean/Fill
31	Power Steering Filter (Reservoir)	Every 75,000 miles	Replace Element
32	Power Steering Filter (Line)	Every 75,000 miles	Replace Element
33	Suspension Air Filter	Every 75,000 miles	Replace Element
34	Air Cleaner	Every 5,000 miles	Inspect/Replace
38	HVAC Air Filter	Every 5,000 miles	Inspect/Clean
N/A	Auxiliary In-Line Air Filters	Every 100,000 miles	Replace Element
N/A	Air System Filter/Dryer (Desiccant)	Every 300,000 miles	Replace Element

CAPACITY SCHEDULE

TRANSMISSION

T-11605-D	Initial Factory Fill: 22 Pts. (10 L)	Service Fill: 22 Pts. (10 L)
T-11605-F	Initial Factory Fill: 22 Pts. (10 L)	Service Fill: 22 Pts. (10 L)
T-14607-A	Initial Factory Fill: 36 Pts. (17.5 L)	Service Fill: 36 Pts. (17.5 L)
TX-14607-B	Initial Factory Fill: 36 Pts. (17.5 L)	Service Fill: 36 Pts. (17.5 L)
RTX-13710-B	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
RTL-14610-A	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
RTA-14710-B	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
HT-740D	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 37 Qts. (35 L)
HT-741	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 34 Qts. (32. L)
HT-746	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 34 Qts. (32. L)
HT-755	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 34 Qts. (32 L)
B-500	Initial Factory Fill: 40 Qts. (38 L)	Service Fill: 26 Qts. (25 L)
B-500R	Initial Factory Fill: 43 Qts. (41 L)	Service Fill: 26 Qts. (25 L)
HD-4060	Initial Factory Fill: 48 Qts. (45 L)	Service Fill: 36 Qts. (34 L)
HD-4060R	Initial Factory Fill: 51 Qts. (48 L)	Service Fill: 36 Qts. (34 L)
	Note: Capacities are approximate only. Please check dipstick levels with the proper "Fluid Level Check" procedure.	*Note: Capacities shown for auto-transmissions are for 4-1/2" standard depth oil pans.*

AXLE

Rockwell	Initial Factory Fill: 32 Pts. (15 L)	Service Fill: 32 Pts. (15 L)

CAPACITY SCHEDULE (Contd.)

ENGINE

8V-92	Initial Factory Fill: 32 Qts. (30 L)	Service Fill: 32 Qts. (30 L)
Series 60	Initial Factory Fill: 38 Qts. (36 L)	Service Fill: 38 Qts. (36 L)
Caterpillar	Initial Factory Fill: 30 Qts. (28 L)	Service Fill: 30 Qts. (28 L)
Cummins	Initial Factory Fill: 38 Qts. (36 L)	Service Fill: 38 Qts. (36 L)
	Note: Capacities are approximate only. Please check dipstick levels with the proper "Fluid Level Check" procedure.	*Note: Capacities shown are for standard deep oil pan. Does not include filters.*

LUBRICATION SCHEDULE

SERVICE INTERVAL A - Every 5,000 Miles (8,000 km) or 150 Hours.

KEYS*	DESCRIPTION	METHOD	SPECIFICATION CODE
7	Slack Adjusters - All	Zerks (6)	S-19 or S-16
24	A/C Compressor Mounting Pivot	Zerk	S-17
13	Differential (Initial Fill - 2,000)	Drain & Fill	S-11 & S-12
4	Manual Transmission (Initial Fill - 3,000)	Drain & Fill	S-3, S-4, S-13, S-14 or S-27
4	Auto Transmission (Initial Fill - 5,000)	Drain & Fill	S-3, S-4, S-13, S-14 or S-27

SERVICE INTERVAL B - Every 10,000 Miles (16,000 km) or 300 Hours.

19	Entrance Door Locking Claw	Apply	S-16
21	Entrance Door Hinges	Apply	S-16
20	Entrance Door Mechanism	Apply	S-17
1	Engine Crankcase Oil (Series 92)	Drain & Fill	S-1
1	Engine Crankcase Oil (Series 60)	Drain & Fill	S-2
17	Clutch Release Bearing	Zerk	S-16
18	Clutch Lever Arm Bearing	Zerk	S-16
23	Clutch Pedal & Control Cables	Spray & Grease	S-24 & S-26
14	Driveshaft Assembly	Zerks (3)	S-17
30	Shutterstat Air Filter	Fill	S-21

SERVICE INTERVAL C - Every 25,000 Miles (40,000 km) or 750 Hours.

10	Drive Axle Brake Chambers	Zerks (2)	S-18
4	Transmission (Automatic)	Drain & Fill	S-15

SERVICE INTERVAL D - Every 50,000 Miles (80,500 km) or 1,500 Hours.

25	Air Cylinders	Apply	S-6
22	Steering Column	2 Zerks	S-17
28	Baggage & Service Doors	Apply	S-18
4	Transmission (Manual)	Drain & Fill	S-3, S-4, S-13, S-14 or S-27
11	King Pin Bushings	Zerks (4)	S-16
6	Steering Drag Link End	Zerks (2)	S-16

LUBRICATION SCHEDULE (Contd.)

SERVICE INTERVAL E - Every 75,000 Miles (121,000 km) or 2,250 Hours.

26	Gear Shift Control Box	Zerk	S-19
18	Rear Shift Shaft Control Housing	Zerk	S-19

SERVICE INTERVAL F - Every 100,000 Miles (161,000 km) or 3,000 Hours.

KEYS*	DESCRIPTION	METHOD	SPECIFICATION CODE
3	Wheel Bearings - All (Oil Lubed)	Drain & Fill	S-9 & S-10
3	Wheel Bearings - All (Grease Lubed)	Apply	S-17
12	Trailing Axle Pivot Arm Bearings	Drain & Fill	S-9
13	Differential (Normal)	Drain & Fill	S-11 & S-12
9	Brake Camshaft Bushings	Zerks	S-16
37	A/C Compressor Clutch Assembly	Zerk	S-20
37	A/C Compressor Unloaders	Apply	S-25
27	Inversion Valve	Apply	S-26
N/A	Brake Valve	Apply	S-26

BRAKE RELINING

9	Brake Slack Adjusters (Drum & Disc)	Zerks	S-16
9	Brake Camshaft Splines (Drum & Disc)	Apply	S-23
9	Brake Camshaft Rollers (Drum Brakes)	Apply	S-19
8	Brake Anchor Pins (Drum Brakes)***	Zerks (4-12)	S-19
16	Brake Caliper (Disc Brakes)***	Zerks (2-4)	S-19

***See Location Diagram (Figure 5) **See Lubricant Specification Chart ***See Inspection Schedule For Components**

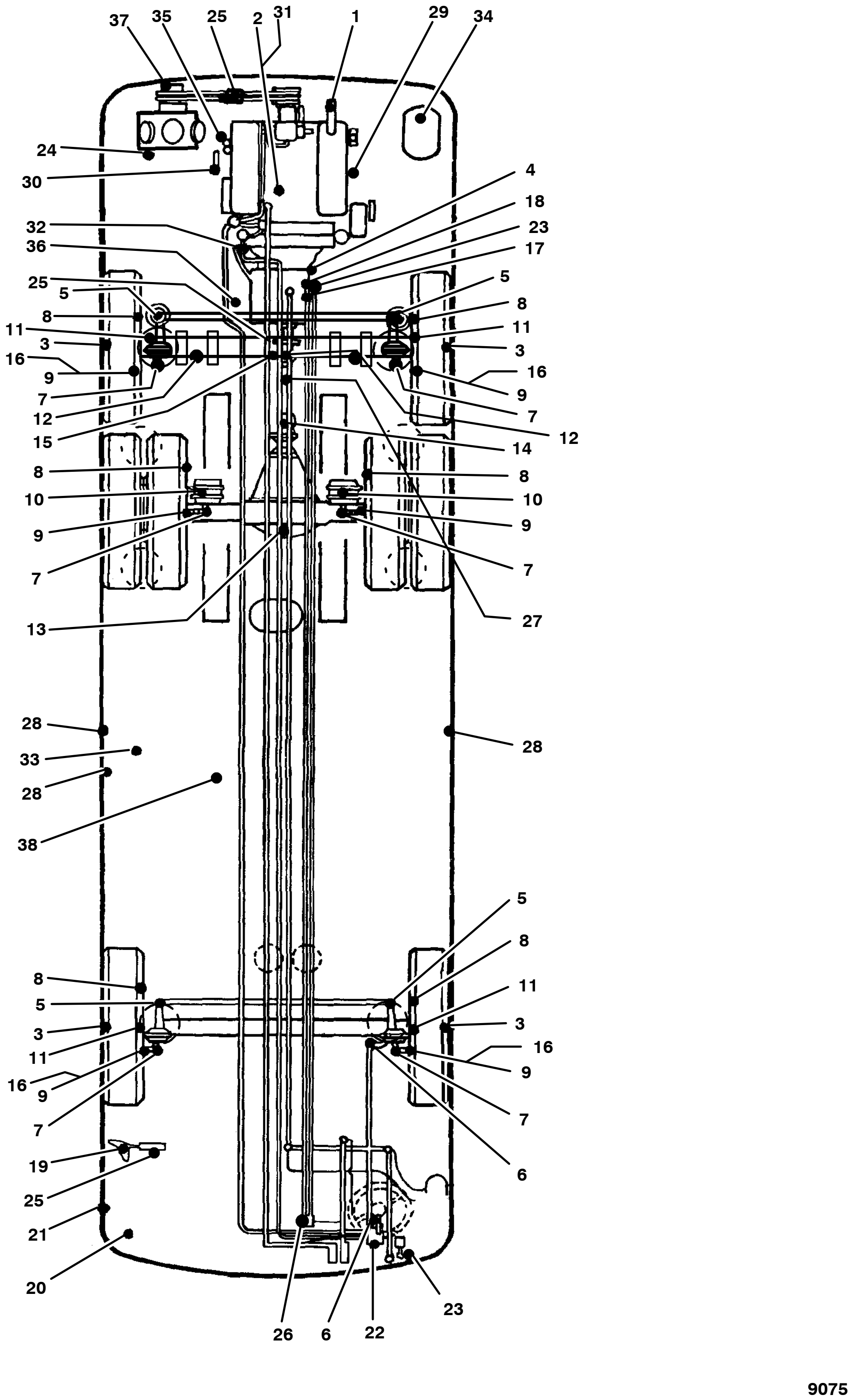
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Figure 5 . Location Keys - Lubricated Items *

PREVENTIVE MAINTENANCE SCHEDULE

The following preventive maintenance schedule is a compilation of suggested maintenance operations contained in this maintenance manual.

Service intervals may be given as regular intervals (Reg. Int.) months and/or miles. Regular intervals must be determined by shop personnel based on operating conditions, component failure history and previous experience. In cases when both time (in months) and miles (in thousands) are given for a particular operation, maintenance should be performed at whichever interval first occurs.

MAINTENANCE OPERATION	Location Key	Months	Reg Int	SERVICE INTERVAL (Miles)													
				5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	75,000	100,000	200,000	250,000	300,000
1 - FRONT AXLE																	
FRONT AXLE INSPECTION			●														
CHECK FRONT AXLE WHEEL ALIGNMENT			●														
LUBRICATE FRONT AXLE KNUCKLE PINS & BUSHINGS	11											●					
LUBRICATE TIE ROD ENDS	5											●					
2 - REAR AXLE																	
CHECK OIL LEVEL - (DIFFERENTIAL)			●														
INSPECT REAR AXLE			●														
DRAIN & FILL - (DIFFERENTIAL)	13	12												●			
INSPECT TRAILING AXLE LATCHING & LOCKING MECHANISM	15			●													
LUBRICATE TRAILING AXLE PIVOT BEARINGS (102D3)	12	12												●			
3 - BODY																	
INSPECT WINDSHIELD WIPERS			●														
INSPECT & ADJUST ALL DOOR LINKAGES		6										●					
INSPECT & LUBE DRIVER'S SEAT			●														
INSPECT WALL & ROOF SEAMS			●														
CHECK & LUBRICATE ALL DOOR LOCKS			●														
LUBRICATE BAGGAGE/SERVICE DOORS	28											●					
LUBRICATE ENTRANCE DOOR HINGES	21				●												
LUBRICATE ENTRANCE DOOR MECHANISM	20				●												
LUBRICATE ENTRANCE DOOR LOCKING CLAW	19				●												
4 - BRAKES & AIR SYSTEM																	
INSPECT AIR RESERVOIR, VALVES,SWITCHES & LINES			●														
INSPECT AIR DRYER		3								●							
DISASSEMBLE AIR DRYER (DESICCANT REPLACEMENT)		36															●
INSPECT SLACK ADJUSTERS			●														
LUBRICATE SLACK ADJUSTERS			●														
INSPECT BRAKE COMPONENT FASTENERS			●														
INSPECT FRONT/REAR/TRAILING BRAKE CHAMBERS		1		●													
DISASSEMBLE FRONT/REAR/TRAILING BRAKE CHAMBERS		12												●			
LUBRICATE REAR BRAKE CHAMBER	10	3								●							
CLEAN & INSPECT ALL BRAKE & RELAY VALVES														●			
INSPECT & LUBRICATE BRAKE ANCHOR PINS (DRUM BRAKES)	8				●												
INSPECT & LUBRICATE BRAKE CALIPER (DISC BRAKES)	16													●			
LUBRICATE BRAKE CAMSHAFTS	9											●					
LUBRICATE SLACK ADJUSTERS	7			●													
LUBRICATE SHUTTERSTAT AIR FILTER	30	2			●												
CLEAN & INSPECT COMPRESSOR & GOVERNOR										●							
CLEAN & LUBRICATE AIR CYLINDERS – ALL	25											●					
CLEAN & LUBRICATE INVERSION VALVES	27	12												●			
CLEAN & INSPECT PARK BRAKE CONTROL VALVE		6										●					

MAINTENANCE OPERATION	Location Key	Months		SERVICE INTERVAL (Miles)													
			Reg Int	5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	75,000	100,000	200,000	250,000	300,000
5 - CLUTCH																	
INSPECT & LUBRICATE CLUTCH LINKAGE CONTROL CABLES	23											●					
LUBRICATE CLUTCH LEVER ARM	18				●												
LUBE CLUTCH RELEASE BEARING	17				●												
6 - COOLING SYSTEM																	
DRAIN AND CLEAN RADIATOR ASSEMBLY		12												●			
CHECK COOLANT COMPONENTS AND COOLANT LEVELS			●														
LUBRICATE SHUTTER ASSEMBLIES			●														
CHECK COOLANT CONCENTRATIONS		1			●												
CHECK FAN DRIVE BELT TENSIONS		2							●								
INSPECT FAN CLUTCHES		3								●							
REPLACE COOLANT FILTER		2							●								
INSPECT WATER PUMP OPERATION		2							●								
7 - ELECTRICAL SYSTEM																	
INSPECT VOLTAGE REGULATOR			●														
INSPECT STARTER			●														
TEST ALTERNATOR OUTPUT			●														
8 - ENGINE																	
DRAIN & FILL ENGINE CRANKCASE OIL	1	2			●												
INSPECT TURBOCHARGER			●														
INSPECT EXHAUST SYSTEM			●														
REPLACE ENGINE OIL FILTERS	29	2			●												
INSPECT ENGINE THERMOSTAT			●														
INSPECT INJECTORS & VALVE LASH			●														
CHECK OIL TEMPERATURE AGAINST COOLANT TEMP.		12												●			
9 - FUEL SYSTEM																	
INSPECT FUEL SYSTEM			●														
REPLACE FUEL FILTERS	35	1			●												
INSPECT THROTTLE DELAY			●														
INSPECT AIR CLEANER	34			●													
11 - STEERING																	
CHECK & FILL POWER STEERING RESERVOIR	2		●														
LUBRICATE DRAG LINK ENDS	6											●					
REPLACE POWER STEERING FILTER (LINE)	32												●				
REPLACE POWER STEERING FILTER (RESERVOIR)	31												●				
INSPECT & LUBRICATE STEERING COLUMN	22											●					
12 - SUSPENSION																	
CHECK RIDE HEIGHT			●														
INSPECT RADIUS ROD BUSHINGS												●					
INSPECT & LUBRICATE TRAILING AXLE LATCHING MECHANISM	15			●													
REPLACE SUSPENSION AIR FILTER	33												●				
INSPECT SUSPENSION AIR SPRING BELLOWS ASSEMBLIES			●														
13 - TRANSMISSION																	
CHECK TRANSMISSION FLUID			●														
DRAIN & FILL TRANSMISSION FLUID (AUTOMATIC TRANMISSION)	4									●							
DRAIN & FILL TRANSMISSION OIL (MANUAL TRANSMISSION)	4											●					
REPLACE TRANSMISSION EXTERNAL/INTERNAL OIL FILTER	36									●							
LUBRICATE GEARSHIFT SELECTOR BOX	26												●				
LUBRICATE SHIFT SHAFT U-JOINTS			●														

MAINTENANCE OPERATION	Location Key	Months		SERVICE INTERVAL (Miles)													
			Reg Int	5,000	10,000	12,000	15,000	18,000	20,000	25,000	30,000	50,000	75,000	100,000	200,000	250,000	300,000
14 - DRIVESHAFT																	
LUBRICATE DRIVESHAFT ASSEMBLY	14	1			●												
15 - WHEELS, HUBS & TIRES																	
CHECK & FILL WHEEL BEARING (OIL LUBED)			●														
LUBRICATE WHEEL BEARINGS (OIL LUBED)	3	3								●							
LUBRICATE WHEEL BEARINGS (GREASE LUBED)	3	12												●			
INSPECT WHEEL BEARINGS & SEALS		12												●			
16 - HEATING & A/C																	
REMOVE & CLEAN EVAPORATOR FILTER			●														
INSPECT A/C COMPRESSOR ASSEMBLY			●														
LUBRICATE A/C COMPRESSOR MOUNT	24	1		●													
LUBRICATE COMPRESSOR CLUTCH	37													●			
INSPECT CONDENSER FAN & MOTOR			●														
INSPECT HVAC BLOWER MOTOR ASSEMBLY			●														
INSPECT & CLEAN PARCEL RACK EVAPORATOR MODULE			●														
CHECK COMPRESSOR OIL LEVEL			●														
CHECK REFRIGERANT LEVEL			●														

SPECIFICATIONS

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE	TEMPERATURE RANGE
S-1	Heavy Duty Engine Oil	MIL-L-2104D/API: CD-II	SAE 40	
S-2	Heavy Duty Engine Oil	MIL-L-2104D/API: CE	SAE 15W-40	
S-3	Heavy Duty Engine Oil	MIL-L-2104D/API: SF/CD	SAE 50	Above 10°F. (-12°C.)
S-4	Heavy Duty Engine Oil	MIL-L-2104D/API: SF/CD	SAE 30	Below 10°F. (-12°C.)
S-5	Heavy Duty Engine Oil	MIL-L-2104D/API: SF/CD	SAE 10W-40	
S-6	Heavy Duty Engine Oil	MIL-L-2104D/API: SF/CD	SAE 10W	

Marketer	Trade Name
MOBIL	DELVAC 1300 (S-1)
SHELL	ROTELLA T (S-2)
MOBIL	MOBIL ATF 210 (S-5)
UNOCAL	GUARDOL (S-5)
TEXACO	TL-1833 (S-5)
MOBIL	MOBIL SUPER (S-3, S-4 & S-6)
TEXACO	HAVOLINE SUPREME (S-3, S-4 & S-6)

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE	TEMPERATURE RANGE
S-7	Blower Box Gear Oil	AGMA 2 EP	ISO 68	15°F. - 68°F.

Marketer	Trade Name
MOBIL	MOBILGEAR 626
EXXON	SPARTAN EP 68
SHELL	OMALA OIL 68
ARCO	PENNANT NL 68
TEXACO	MEROPA 68

S-8	Blower Box Gear Oil	AGMA 4 EP	ISO 150	50°F. - 125°F.

Marketer	Trade Name
MOBIL	MOBILGEAR 629
EXXON	SPARTAN EP 150
SHELL	OMALA OIL 150
ARCO	PENNANT NL 150
TEXACO	MEROPA 150

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE	TEMPERATURE RANGE
S-9	Multipurpose Gear Oil	MIL-L-2105D/API: GL-5	SAE 85W-140	10°F. - 125°F.
S-10	Multipurpose Gear Oil	MIL-L-2105D/API: GL-5	SAE 75W-90	-40°F. - 125°F.
S-11	Hypoid Gear Oil	MIL-L-2105D/API: GL-5	SAE 85W-140	12°F. - 121°F.
S-12	Hypoid Gear Oil	MIL-L-2105D/API: GL-5	SAE 75W-80	-40°F. - 121°F.
S-13	Mineral Gear Oil	MIL-L-2105D/API: GL-1	SAE 90	Above 10°F. (-12°C.)
S-14	Mineral Gear Oil	MIL-L-2105D/API: GL-1	SAE 80W	Below 10°F. (-12°C.)

Marketer	Trade Name
MOBIL	MOBILUBE HD (S-9 thru S-12)
CHEVRON	ULTRA (S-9 thru S-12)
CHEVRON	ARCTIC (S-9 thru S-12)
MOBIL	MOBILUBE C (S-13 & 14)

SPECIFICATIONS (Contd.)

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-15	Automatic Transmission Fluid	ATD C-4	DEXRON IIE

Marketer	Trade Name
MOBIL	MOBIL ATF 220
EXXON	SUPERFLO ATF
SHELL	DONAX TG PLUS
ARCO	ATF DEXRON/MERCON
TEXACO	ATF MERCON?DEXRON IIE M/P

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-16	Multi-Purpose Grease	NLGI 6% Lithium/12-Hydroxy Stearate	EP 1
S-17	Multi-Purpose Grease	NLGI 8% Lithium/12-Hydroxy Stearate	EP 2
S-18	Multi-Purpose Grease	NLGI Neutral Lithium/Mineral Oil	EP 1
S-19	Multi-Purpose Grease	NLGI Clay-Base/Poly-Urea	EP 1
S-20	Multi-Purpose Grease	NLGI Paraffinic-Base/Poly-Urea	EP 1

Marketer	Trade Name
MOBIL	MOBILITH AW-1 (S-16)
EXXON	RONEX MP-2 (S-17)
LUBRIPLATE	AERO (S-18)
SHELL	DARINA EP 1 (S-19)
CHEVRON	SR 1 (S-20)

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-21	Shutterstat Filter Fluid	N/A	N/A

Marketer	Trade Name
KYSOR	SHUTTERSTAT FLUID

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-22	A/C Compressor Oil (R-12/22)	N/A	N/A

Marketer	Trade Name
DUPONT	ZEPHRON 150
SUNOCO	SUNISCO 4G
TEXAS OIL	CAPELLA D

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-23	Anti-Seize Compound	N/A	N/A

Marketer	Trade Name
WITCO	CORROSION CONTROL

SPECIFICATIONS (Contd.)

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-24	Silicon Spray Compound	N/A	N/A
S-25	Silicon Fluid	N/A	N/A
S-26	Silicon Grease	N/A	N/A

Marketer	Trade Name
DOW CORNING	316 (S-24)
DOW CORNING	200 (S-25)
DOW CORNING	55 O-RING LUBE (S-25)

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-27	Synthetic Manual Gear Lube	API GL-3 EP	SAE 50

Marketer	Trade Name
EATON	ROADRANGER CD 50
MOBIL	MOBILTRANS SHC-50

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-28	A/C Compressor Oil (R-134A)	Ester-Based	N/A

Marketer	Trade Name
CASTROL	SW-68 (ICEMATIC)

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE	TEMPERATURE RANGE
S-29	Hypoid Gear Oil	MIL-L-2105D/API: GL-5	SAE 80W-90	-30°F. - 121°F.

Marketer	Trade Name
EXXON	GEAR OIL GX

CODE	DESCRIPTION	SPEC/CLASSIFICATION	GRADE
S-30	Heavy Duty Engine Coolant	Ethylene Glycol	N/A

Marketer	Trade Name
Detroit Diesel	Power Cool

NOTE: Lubricant Grade And/Or Viscosity Shown Are Manufacturer Recommended.

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 11

STEERING SYSTEM

This section consists of four primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The four primary subsections are:

A - Steering System
B - Steering Wheel and Column
C - Power Steering Pump
D - Steering Gear TAS-85 Series

SECTION 11A

STEERING SYSTEM

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 11A-1
Operation 11A-1
Components 11A-2
Maintenance 11A-2
Troubleshooting 11A-7
Torque Chart 11A-11
Specifications 11A-11

GENERAL DESCRIPTION

All D series coaches utilize a hydraulically assisted steering system. Input from the steering column is power assisted by the integral power steering gear and transferred by way of a pitman arm to the drag link, which in-turn is connected to the front axle steering arm (Figure 1). The integral power steering gear's hydraulics are pressure piped from the power steering pump mounted on and driven by the desiel engine.

Some minor differences in mounting of the hydraulic pump to the engine gear case occur between the Series 60 and 8V-92 engines, and steering arm to axle orientations are different for drum and disc brake axles, otherwise, the steering systems are similar.

OPERATION

Hydraulic fluid from the reservoir is pressurized by the pump and feed through hydraulic fluid lines to the steering gear. Hydraulic fluid displaced by the pump powers the steering gear action. A return line is connected from the steering gear back to a reservoir.

When the steering wheel is turned the steering column shaft turns the power steering gear's input shaft. This actuation, combined with hydraulic pressure supplied to the gear's internal piston by the pump, provides the power assisted rotating action of the gear's output shaft and pitman arm.

Finally, this action is transferred by way of the drag link to the axle's steering arm and knuckle.

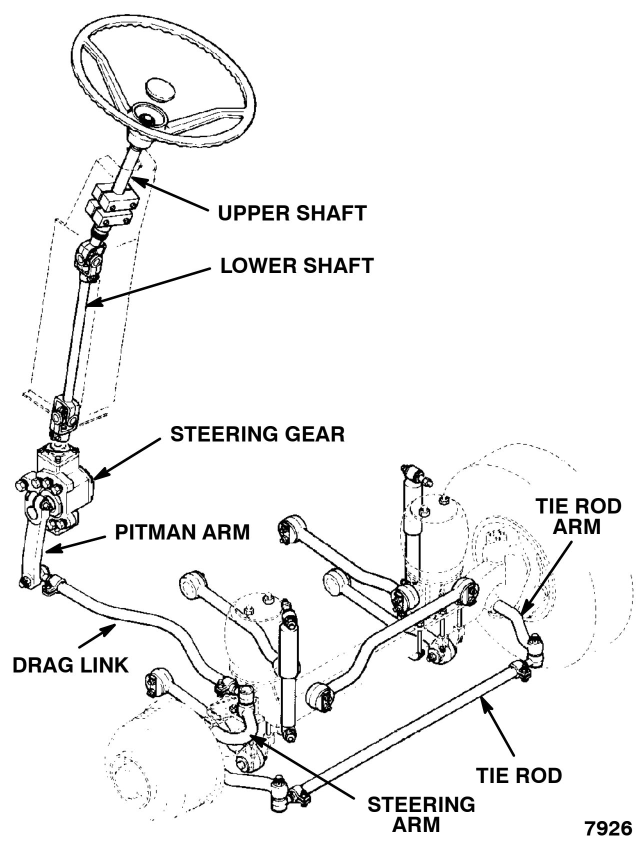


Figure 1. Power Steering System

Steering system and tire wear are affected by air suspension, brakes, wheel bearings, front suspension and front end alignment. These items are covered in their respective sections of this manual. Steering system specifications are given at the end of this section.

COMPONENTS

The power steering system consists of several major components such as steering column, steering gear and hydraulic pump, that will be discussed in detail in later sub-sections. This sub section will provide information on the typical components found in the D series coaches, such as hydraulic lines, steering linkage and fluid reservoirs and filters.

POWER STEERING LINES

The pressurized hydraulic fluid flows through the pressure feed and return power steering lines (Figure 2). These lines are composed of rigid copper through the center tunnel area with flexible hose connections at each end.

CAUTION

Due to the close proximity of primary coach control piping (i.e. power steering lines) within the center tunnel module to the underside of floorboards, any alterations and/or attachments to the floorboards in this area should be undertaken with extreme caution.

The power steering pressure feed to steering gear features an in-line hydraulic fluid filter, and return line connected directly to the filter/reservoir assembly.

STEERING LINKAGE

The steering drag link ties the steering gear to the front axle. This drag link is fastened to the steering gear's pitman arm and the axle's steering arm. The drag link assembly consists of a heavy bent tube and pivoting ends with positive locking clamps.

FILTERS AND RESERVOIRS

The power steering system features a filter/reservoir canister in the engine compartment and also an in-line filter from the pump

MAINTENANCE

POWER STEERING LINES

The power steering system pressure lines require little maintenance. However, the system should be kept clean to ensure maximum operating performance and trouble free service. Periodic inspection should also be made to check for leaks.

Air in the fluid system will cause spongy action and noisy operation. When any hose has been disconnected or when fluid has been lost for any reason, the system must be bled. Bleed the system as described under "Bleeding System" later in this section.

STEERING LINKAGE

If the linkage between the steering gear and the front wheels is out of adjustment, bent, twisted or worn, the steering action of the coach will be seriously affected. Whenever any steering linkage parts are repaired, replaced or adjusted, steering geometry and front wheel alignment must be checked and necessary corrections made. Refer to section 1 "Front Axle" for front end alignment information.

At regular lubrication intervals, as noted in section 10, the steering linkage should be thoroughly inspected for worn or loose components. Any loose components should be retorqued as shown in the torque chart at end of this sub-section.

After the coach has been operated continually, and high mileage figures have been reached, inspection and/or overhaul of the various steering linkage components may be required see "Steering Linkage Inspection" later in this section.

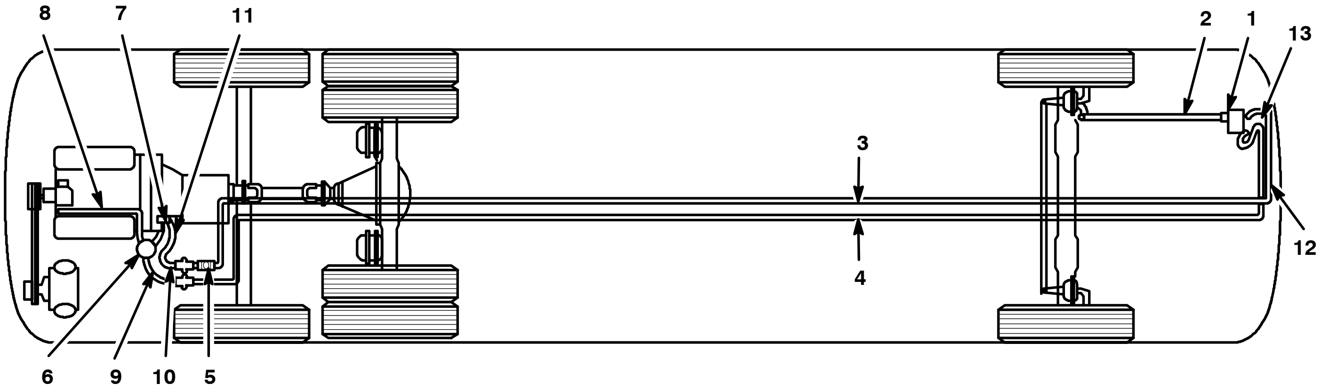
General overhaul procedure normally requires removal and disassembly of the entire assembly, cleaning and inspection of all parts and final assembly. Careful inspection of all parts during overhaul is very important and must not be neglected.

CAUTION

When removing and reinstalling the steering column be sure debris is not left around the bottom yoke of the lower steering column, where the column passes through the floor board. Debris left here can cause the steering column to bind. If this happens, additional steering effort will free the column. However, the debris will still remain and must be removed. Once cleaned, additional debris cannot fall into this area when the steering column cover and closing cover are properly installed.

FILTERS AND RESERVOIRS

The fluid reservoir and filter assembly is mounted in the upper right corner of the engine compartment. When the slightest evidence of dirt, sludge or water is discovered in the system, disconnect fluid lines at the power steering gear. Drain, and refill the system with clean, recommended fluid. The power steering fluid reservoir filter should be serviced at regular lubrication intervals.



1. STEERING GEAR
2. DRAG LINK
3. FEED LINE
4. RETURN LINE
5. POWER STEERING PRESSURE FILTER
6. RESERVOIR AND FILTER
7. POWER STEERING PUMP
8. POWER STEERING FLUID FILL
9. HOSE–RESERVOIR RETURN FROM QUICK DISCONNECT
10. HOSE–PUMP OUTLET TO QUICK DISCONNECT
11. HOSE–RESERVOIR TO PUMP
12. HOSE–FEED AND RETURN LINES TO STEERING GEAR
13. POWER STEERING VALVE

7938

Figure 2. Steering Lines and Component Locations

At regular intervals, fluid level in the pump reservoir should be checked and fluid added when required. Refer to ”Filling Procedure” later in this section.

The power steering fluid line filter is in-line mounted. At regular lubrication intervals, the fluid filter element should be removed and replaced. Refer to Power Steering Filter later in this section for service instructions.

NOTE: The power steering hydraulic system has two filters to ensure that foreign matter does not enter the pump or the steering gear. A filter in the reservoir filters the steering fluid before it enters the pump and a supply line filter is used to filter the fluid before it enters the steering gear.

⚠ CAUTION ⚠

Do not operate the pump without fluid in the pump reservoir.

FILLING POWER STEERING SYSTEM

NOTE: For steps 1 and 2, do not turn the steering wheel. Otherwise, air will enter the system.

1. Fill the reservoir nearly full as shown in figures 5 and 7. Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it off immediately.

2. Check and refill the reservoir as necessary. Perform this procedure three times, each time checking and refilling the reservoir.

⚠ CAUTION ⚠

Do not allow the fluid to drop significantly or run out of the system. This will allow air into the system.

3. Start the engine and let it idle for two minutes, shut the engine off and check the fluid level in the reservoir.

4. Start the engine. Steer the coach from full left to full right several times.

5. Add fluid to reservoir until it reaches the halfway point in the sight glass.

BLEEDING SYSTEM

NOTE: This procedure is to be followed any time the hydraulic loop has been opened, depending on what area has been worked on. The time to bleed the system could be considerably less than for a total system purge.

1. Ensure all power steering connections have been made and are properly tightened.

2. Add fluid (10W-40 oil) to reservoir and fill until oil is to bottom of fill spout in reservoir cover.

3. Start engine, but do not operate at higher than idle rpm.

4. At the instant the engine starts, oil level will drop in the reservoir as oil fills the supply line to the power steering gear. Oil must be continually added to ensure pump inlet is not allowed to starve or run dry.

5. When oil level stabilizes within the reservoir, the oil level should be brought to the sight glass level.

6. With the engine at idle speed, the steering wheel should be turned lock-to-lock at least six times. When all air is removed from the system, air bubbles will no longer surface through the oil in the reservoir. While air bubbles are still surfacing, it indicates that the system is not completely bled. In this case the steering wheel must continue to be cycled lock-to-lock and the oil level must be constantly monitored and oil replenished.

7. With the system fully bled, fill the reservoir to specified levels. Replace cap on reservoir.

POWER STEERING IN-LINE FILTER

The power steering filter is located in the upper right side of the engine compartment (Figure 3). This is a pressure line filter. At regular intervals or 50,000 miles (80,000 km), the filter should be removed and replaced.

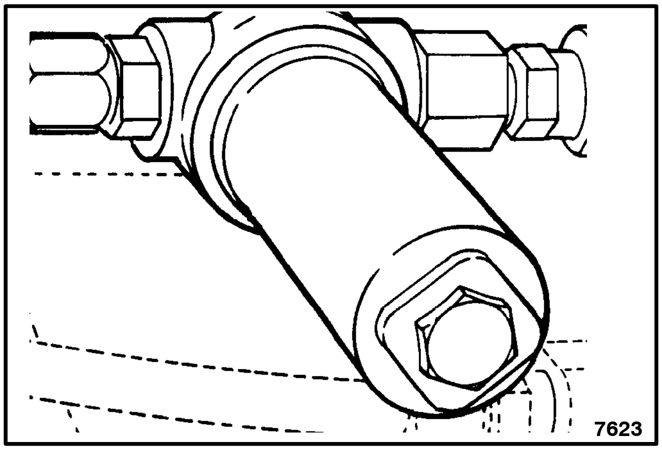


Figure 3. Power Steering Filter

NOTE: This filter should be replaced in conjunction with servicing and replacing the reservoir filter element. The power steering system should be bled at this time.

1. Shut down the system and release all pressure in filter line.

2. Unscrew the bowl and lower it vertically to clear the element assembly (Figure 4).

3. Remove the element from the filter head by pulling it from the element locator. Discard and replace with new element.

4. Install new element by pushing it onto the locator.

5. It is recommended that the bowl O-ring be replaced before refitting to the housing.

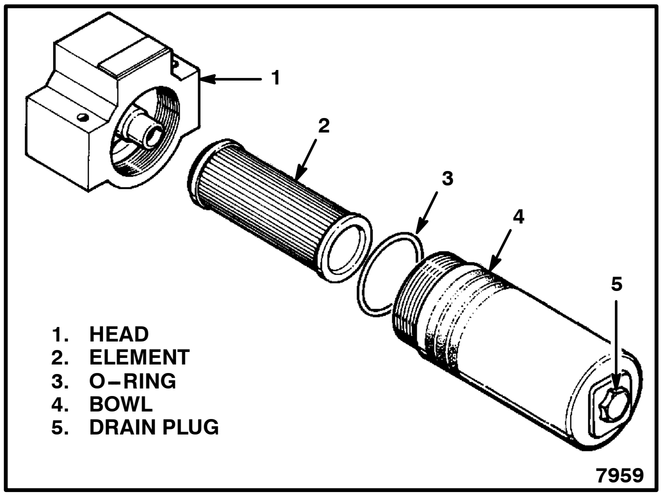


Figure 4. Power Steering Filter

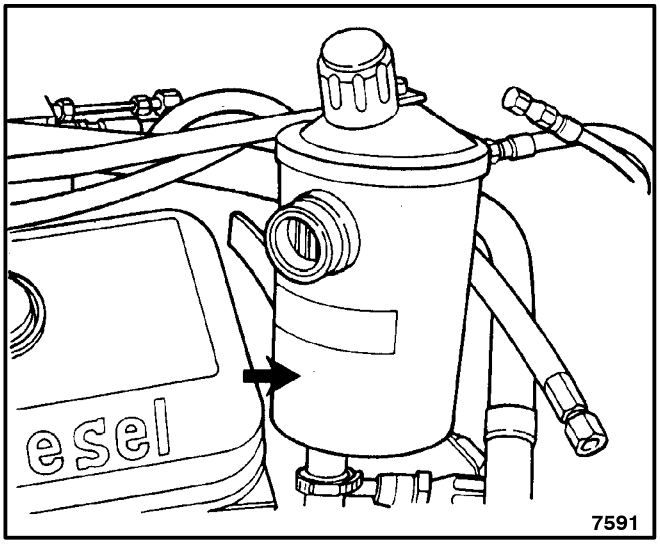


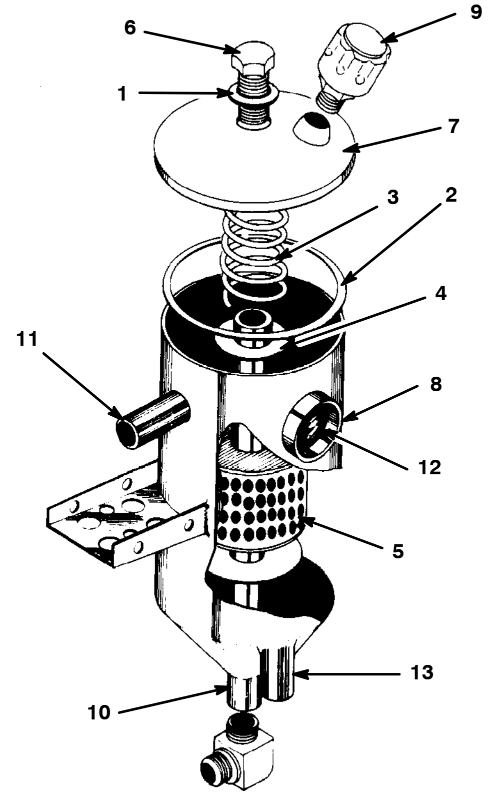
Figure 5. Power Steering Reservoir and Filter

POWER STEERING FILTER/RESERVOIR

A power steering reservoir, filter and sight gauge (Figure 5) are located in the upper right-hand side of engine compartment.

The filter element should be serviced at the same intervals as replacing the power steering pressure filter element, approximately 50,000 miles (80,000 km), depending on operating conditions. When replacing the element refer to (Figure 6).

The remote filler nozzle for the reservoir on the 8V-92 engine is located along the top right hand side of the engine (Figure 7). The reservoir's fill nozzle for the series 60 engine is located on the reservoir mounted to the right hand side of the engine.



1. COVER BOLT GASKET
2. COVER GASKET
3. CARTRIDGE RETAINING SPRING
4. CARTRIDGE SUPPORT WASHER
5. FILTER CARTRIDGE
6. COVER BOLT
7. COVER
8. SHELL
9. BREATHER CAP
10. RESERVOIR INLET
11. FILLER INLET
12. SIGHT GLASS
13. OUTLET

Figure 6. Reservoir Filter Parts

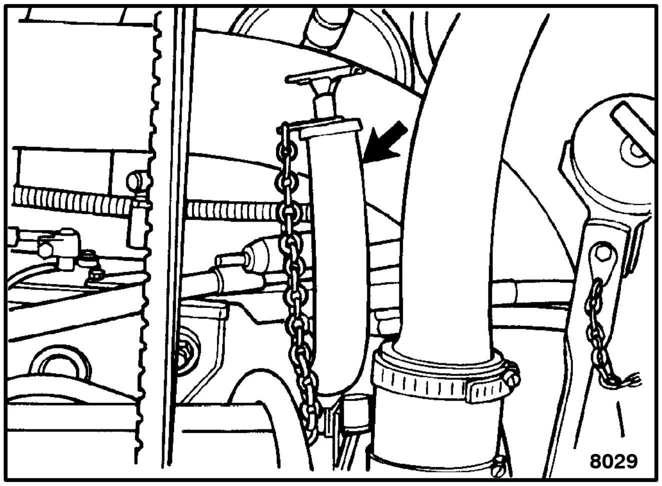


Figure 7. Power Steering Reservoir Fill

NOTE: After new element and gaskets are installed, install cover and bolt assembly. Check for leaks after operating system.

STEERING LINKAGE INSPECTION

It is the manufacturer's recommendation that at major inspections or every 300,000 miles (480,000 km), depending on operating conditions, the front end steering components be Magnaflux or Magnaglo inspected. This also applies when purchasing a used coach.

This recommendation is due to various hazards while coach is in service; extremely rough road surfaces, curbing of tires, or accidents. In some instances at disassembly of steering components, damage may also be caused due to heavy hammering or application of heat.

Important steering parts to be Magnaflux or Magnaglo inspected are the following:

Pitman Arm

Drag Link Ends

All Ball Studs

Cross Tube End and Steering Arms

Main Steering Arm

Lever Shaft (Sector)

Worm Shaft

Axle Spindles

Other components being visually inspected that may be doubtful should also be included in the Magnaflux or Magnaglo inspection.

⚠ CAUTION ⚠

Do not utilize any methods for repair on steering components such as welding, metal plating, etc. Replace with genuine new parts.

Removal And Inspection

1. Remove the cotter pins and castle nuts from the drag link ends (Figure 8).
2. Remove the drag link.
3. Loosen the clamps and unscrew the ends from the drag link rod.
4. Carefully inspect all parts and replace any that are worn or damaged. Magnaflux or Magnaglo inspection procedure is recommended.
5. Clean components with a suitable cleaning fluid.
6. Lubricate all studs and tapers. Reassemble them in reverse order of disassembly. Tighten clamp bolts and the castle nuts at each end of drag link to torques shown in the torque chart (Figure 9).

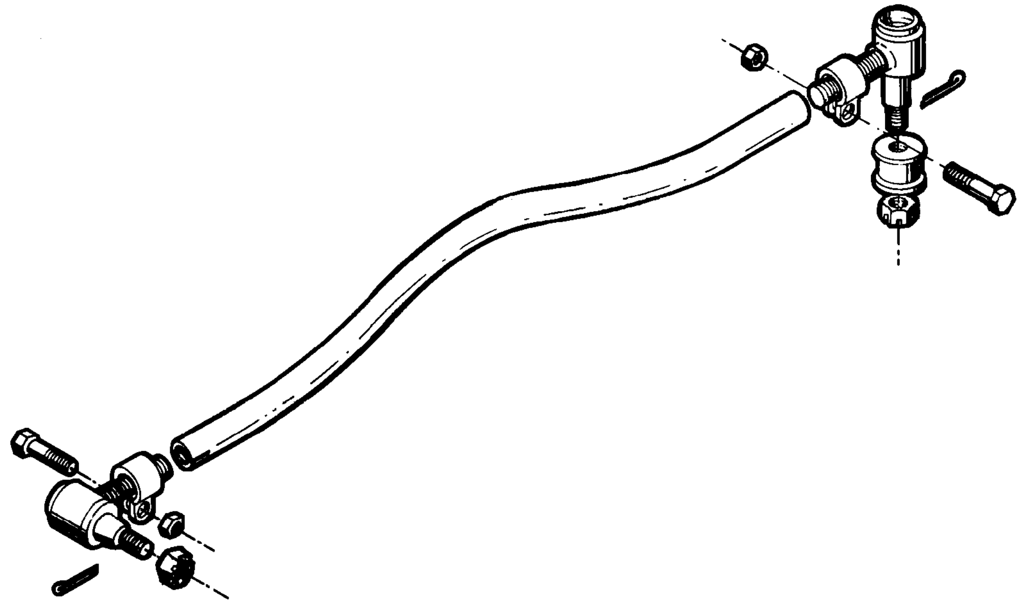


Figure 8. Drag Link

NOTE: When installing the clamps on the drag link ends, the open side of the clamps must be turned downward and the clamp bolts inserted as shown in Figure 8.

Inspection Procedure

1. Remove the cotter pin and loosen the castellated nut fastening the steering drag link and back off three full turns.

2. Check for looseness in the tapered connection by applying hand pressure against the drag link in a direction away from the pitman arm. DO NOT hit the ball stud or drag link with a hammer, pry bar or other object in an attempt to unseat the taper. If the taper connection is not properly seated, hand pressure alone will be sufficient to separate the parts.

3. If the tapered connection remains together, reinstall the castellated nut and torque to 230-260 ft-lbs (311-353 N·m). Install a NEW cotter pin (1⁄8" x 1 1⁄2"). Do not back off the nut to insert the cotter pin into the ball stud cotter hole. If necessary, tighten the nut further to the next closest slot, to install the cotter pin.

TROUBLESHOOTING

TROUBLE	REMEDY
PUMP NOT DELIVERING FLUID Drive in wrong direction of rotation. Pump driveshaft disengaged or sheared.	1. Check direction of pump shaft rotation. 2. Remove pump; determine damage to cartridge parts (see disassembly instructions); replace sheared shaft and damaged parts. Refer to Power Steering Pump.
Flow control valve stuck open.	1. Disassemble pump and wash control valve in a clean solvent. 2. Return valve to its bore and slide it back and forth. No stickiness in movement should occur. If a gritty feeling is noted on the valve O.D., it may be polished with a crocus cloth. Avoid removal of excess material or round off of valve edges during this operation. Do not attempt to polish the valve bore. 3. Wash all parts before reassembling of pump. 4. Flush entire system thoroughly and fill with clean oil as recommended.
Vane(s) stuck in rotor slots.	1. Disassemble pump, examine rotor slots for dirt, grime or small metal chips. 2. Clean rotor and vanes in a good grade solvent (mineral spirits or kerosene); reassemble parts and check for free vane movement.
Fluid viscosity too heavy to prime. Pump intake partially blocked.	1. Use fluid of the viscosity as recommended. 2. Drain system completely; flush to clear pump passages. 3. Flush and refill system with clean oil as recommended.
Air vent for oil reservoir clogged, or dirty strainer.	1. Remove filler cap and clean air vent slot. 2. Check filter or strainer in tank for clogged condition. 3. Drain, flush and add clean oil to system if strainer was clogged.
PUMP MAKING NOISE Restricted or partially clogged intake line or clogged filter.	Pump must receive intake oil freely or cavitation will result. 1. Drain system, and clean intake line and strainers. 2. Add new oil and strain by recommended procedures.
Air leak at pump intake piping joints or pump shaft seal.	1. Test by pouring oil on joints and around drive shaft. 2. Listen for change in operation. 3. Tighten joints affected and replace pump drive shaft seal according to service instruction; refer to Power Steering Pump.
Coupling misalignment.	Realign and replace oil seal and bearings if damaged by shaft misalignment.

TROUBLESHOOTING (Contd.)

TROUBLE	REMEDY
Reservoir or manifold seal leakage. Leakage between manifold or reservoir at replenishing hole due to O-ring damage.	1. The reservoir inlet-tube-to-pump-cover O-ring should be carefully examined for damage such as cuts, nicks or dirt. 2. Replace as necessary. Refer to Power Steering Reservoir and Filter.
HARD STEERING EITHER WHILE PARKING OR EXISTING ALL THE TIME. Insufficient pump pressure.	1. Check pump pressure with gauge. 2. If sufficient, check for cause - sticky relief valve in pump or flow control.
Defective pump.	Repair or replace defective parts.
Sticky control valve in pump or flow control which prevents pressure build-up.	Replace valve. (May require total pump replacement.) Refer to Power Steering Pump.
“LUMPY” FEELING (SPOTS OF HARD STEERING) Delayed power application.	Check and eliminate excessive free play in steering linkage.
Air in steering system.	Bleed system as per previous instruction.
Loose joints or linkage.	Tighten where necessary.
Insufficient oil flow.	1. Check for damaged hoses, weak or sticking valve spring, or worn pump parts. 2. Repair or replace as necessary.
Low oil supply.	Check level and refill.
HARD STEERING ACCOMPANIED BY ABNORMAL NOISE Air in system.	Bleed as per instructions in Bleeding Air from Power Steering System.
HARD STEERING ACCOMPANIED BY ABNORMAL NOISE Pump malfunction.	See Power Steering Pump, Inspection and Repair.
Low oil supply	See Power Steering Pump, Inspection and Repair.
NO RECOVERY FROM TURN TO STRAIGHT AHEAD Insufficient caster.	Increase caster; refer to Front Axle Specifications Chart, Section 1.
Tight ball socket connections and other linkage connections.	Loosen connections but keep them snug.
Tight front axle spindles.	Adjust linkage; refer to Section 1.

TROUBLESHOOTING (Contd.)

TROUBLE	REMEDY
Spool in steering gear valve sticking. (Prevents centering of valve.)	1. Disassemble valve and inspect for sticking. 2. Clean. 3. Reassemble valve or replace and reinstall on gear. See HFB70 Integral Steering Gear.
Tire pressure low.	Check pressure and inflate tires.
Front end out of alignment.	Align front end; refer to Section 1.
Steering column binding.	Eliminate bind; refer to Steering Column.
Pump flow insufficient.	Check pump pressure with gauge. If insufficient check for cause and repair pump and/or lines; refer to Power Steering Pump.
Steering gear improperly adjusted.	Adjust to specifications.
SHIMMY Loose ball socket connections or other linkage connections.	Tighten; see Section 1.
Wheels out of balance.	Balance.
Wheel bearings improperly adjusted or worn.	Check bearings; replace if necessary.
Excessive caster.	Correct and have front alignment checked to specifications.
EXTERNAL OIL LEAKAGE.	The location of leak may be difficult to find, as oil may flow away from leak point of the gear to the frame or chassis. 1. Check all fittings, clamps, hoses and pump. 2. Repair or replace any possible causes of leakage.
EXCESSIVE PUMP PRESSURE WITH STEERING GEAR IN NEUTRAL POSITION	
Kink in oil return line.	Relocate line to remove kink.
OTHER CAUSES OF HARD STEERING	
Caster and camber degree incorrect.	Correct to specification; see Front End Alignment Chart, Section 1.
Air in system.	Bleed system and check for source of air.

TROUBLESHOOTING (Contd.)

TROUBLE	REMEDY
LOST MOTION OR LASH AT STEERING WHEEL.	
Steering wheel loose on shaft.	Tighten to specifications.
Loose connections between gear and steering column	Tighten connections; refer to Steering Column.
Steering gear loose on frame.	Tighten.
Pitman arm loose on sector shaft.	Tighten or replace where necessary.
Steering gear improperly adjusted.	Adjust.
OVERHEATING OF STEERING GEAR	
Undersize replacement hose or line.	Replace with correct size hose or line.
Restricted hose or line due to kink or severe bend.	Relocate line or hose to remove kink.
Restricted recentering of valve due to column binding or side loading of input shaft.	Inspect and repair gear to correct; refer to Steering Gear.

⚠ CAUTION ⚠

If the hydraulic system fluid becomes overheated, it can cause the seals in the steering gear to shrink, harden, or crack and lose their sealing ability.

TROUBLE	REMEDY
EXTERNAL OIL LEAKAGE	Replace oil seal.
Rubber relief (vent) plug leaking at side cover indicates failure of sector shaft oil seal in side cover.	
OVERHEATING OF STEERING GEAR	Adjust to specifications.
Poppets not properly adjusted.	

TORQUE CHART

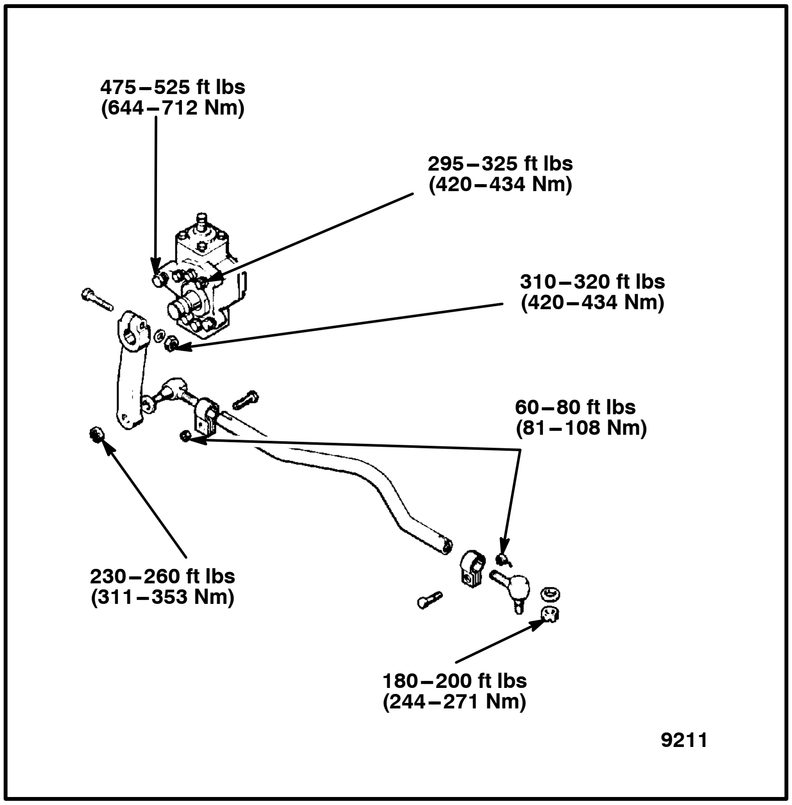

475–525 ft lbs
(644–712 Nm)
295–325 ft lbs
(420–434 Nm)
310–320 ft lbs
(420–434 Nm)
60–80 ft lbs
(81–108 Nm)
230–260 ft lbs
(311–353 Nm)
180–200 ft lbs
(244–271 Nm)
9211

Figure 9. Torque Chart

SPECIFICATIONS

POWER STEERING RESERVOIR

Manufacturer	Walker Deluxe
Model	326497
Mounting Location	Engine Rear (8V-92)
Mounting Location	Engine Front (Series 60)

POWER STEERING FILTER

Manufacturer	Parker
Model	15P-1-40W-14190
Mounting Location	Front of Engine Compartment

DRAG LINK

Manufacturer	TRW
Part Number	11K-4-14

PITMAN ARM

Manufacturer	Ross Gear Division/TRW
Part Number	11G-1-3

SECTION 11B

STEERING WHEEL AND COLUMN

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 11B-1

Components 11B-1

Maintenance 11B-2

Torque Chart 11B-10

Specifications 11B-11

GENERAL DESCRIPTION

The steering column assembly transfers the mechanical input of the steering processes to the power assisted steering gear. The basic fixed or optional tilt and telescoping upper steering columns are used on the D series coaches.

The optional column allows increased clearance between the steering wheel and the driver's seat and allows adjustments for driver comfort.

COMPONENTS

FIXED STEERING COLUMNS

The fixed steering columns (Figure 1) are constructed of an upper and lower section. The steering wheel is mounted to the upper shaft, which is part of the upper section along with the steering wheel jacking tube and column bearing assemblies. The upper section also contain components essential to horn function.

The lower section consists of a splined shaft that connects to upper section U-joint, and another lower clamping yoke U-joint assembly that couples to the steering gear's input shaft.

TILT/TELESCOPING STEERING COLUMNS

The optional tilt/telescoping steering columns (Figure 2) are also designed with an upper and lower section. The steering wheel mounts to an upper wheel tube that slides over the housing mounted internal U-joint assembly, and in-turn connects to a lower U-joint and clamp yoke assembly that composes the upper section.

The lower section consists of a splined shaft that connects to upper section U-joint, and incorporates a lower U-joint and clamping yoke at the steering gear joint.

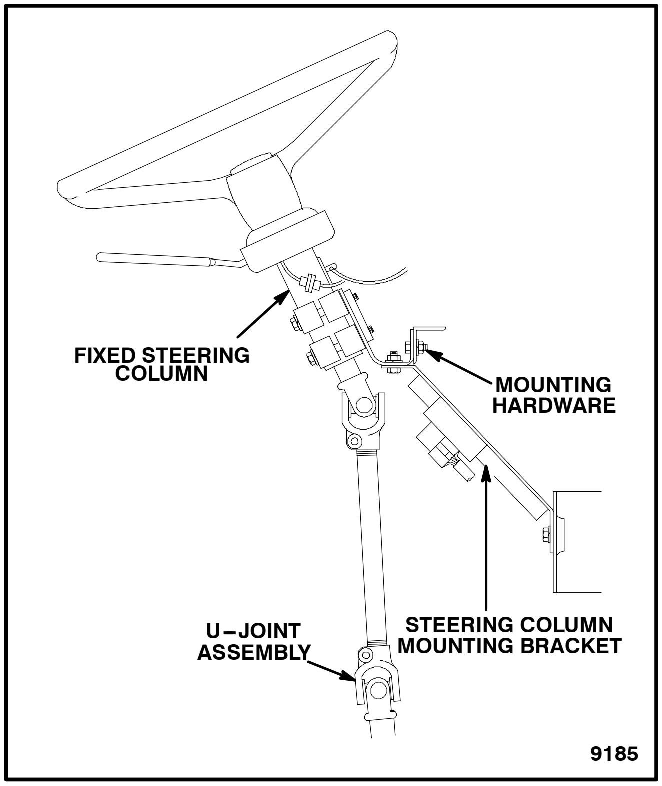


Figure 1. Fixed Steering Column

The upper tilt/telescoping section features a wear compensating mechanism which provides vibration and rattle free performance.

Tilt and telescope functions are controlled by a single lever which is mounted in a vertical position on the left side of the column. Pulling the lever outward to the left allows tilting; pushing the lever inward to the right allows telescoping.

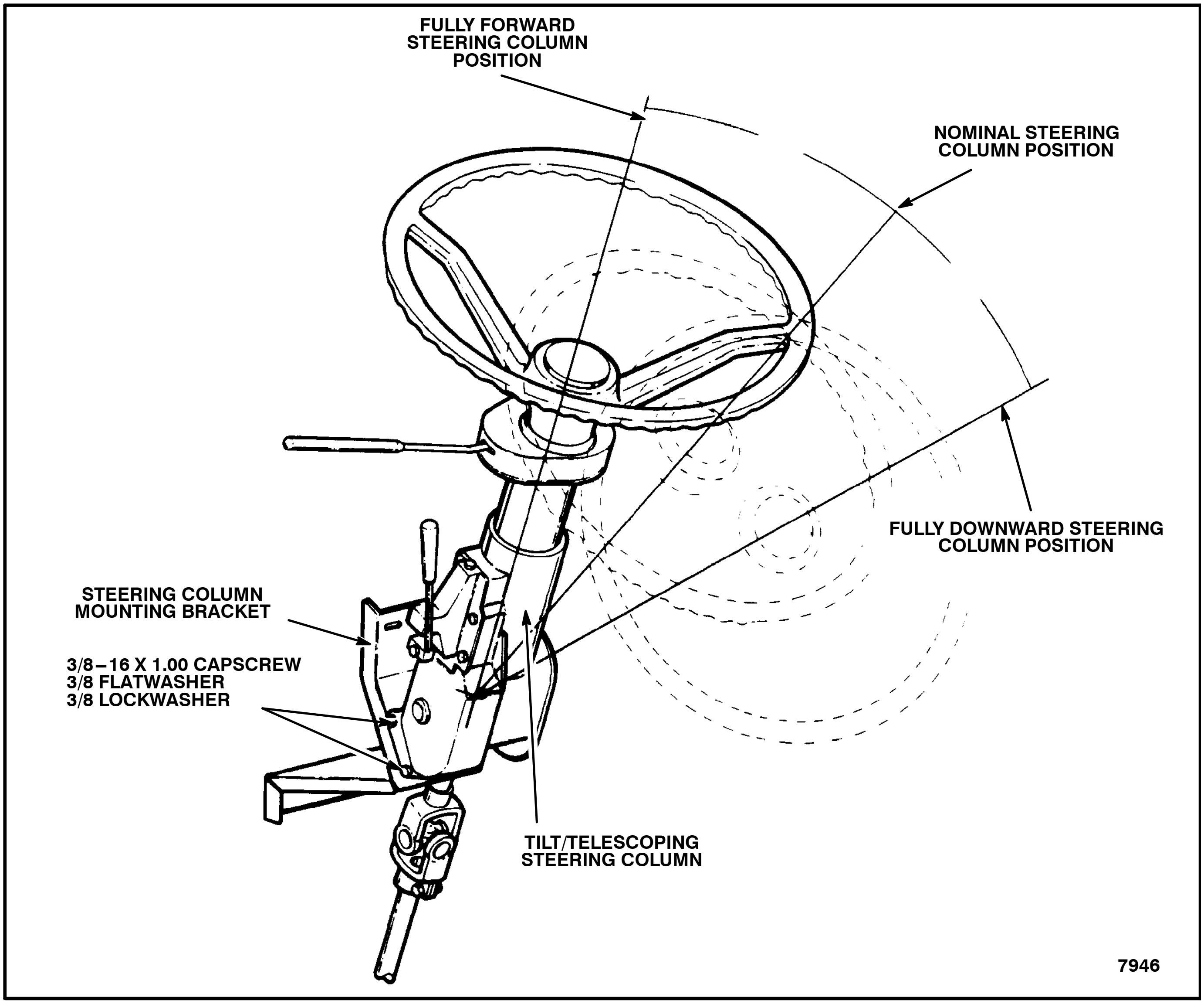

FULLY FORWARD STEERING COLUMN POSITION
NOMINAL STEERING COLUMN POSITION
FULLY DOWNWARD STEERING COLUMN POSITION
STEERING COLUMN MOUNTING BRACKET
3/8−16 X 1.00 CAPSCREW
3/8 FLATWASHER
3/8 LOCKWASHER
TILT/TELESCOPING STEERING COLUMN
7946

Figure 2. Tilt/Telescoping Steering Column

Tilting is done in 5-degree increments to a 10-degree upward position and to a 20-degree downward position from the nominal column position. Telescoping can be done in small increments through approximately a two-inch range. A sequential tilt/latch mechanism ensures positive latching and locking of the column at the 5-degree intervals.

MAINTENANCE

LUBRICATION

Grease the steering column U-joints at 50,000 mile intervals per the lubrication specification chart in section 10. Remove steering column cover for access to grease fitting.

COLUMN REMOVAL

Fixed Steering

1. Turn the battery switch to “Off”.
2. Unfasten and remove the steering column cover assembly.
3. Unfasten and remove wheel nut and pull the steering wheel off shaft serrations, and replace wheel mounting nut onto shaft.

⚠ CAUTION ⚠

Use a suitable “wheel puller” to remove the steering wheel.

4. Disconnect the wire from the contact brush terminal located under the turn signal assembly on the left side of the steering column.

5. Loosen and remove allen head screws securing the turn signal assembly, and remove it from the steering column.

6. Loosen the clamping yoke connecting the lower steering column section to the input shaft of the steering gear.

7. Unfasten and remove the U-clamps that secure the upper column section to the mounting bracket. The steering column may now be lifted out of the coach as a complete unit.

Tilt/telescoping Steering

1. Follow steps 1 – 5 of the ”Fixed Steering” removal procedure.

2. Unfasten and remove the lower shaft yoke clamp that connects the lower column section to the steering gear’s input shaft.

3. Unfasten and remove the capscrews that secure the upper column section’s housing to the mounting bracket. The steering column may now be lifted out of the coach as a complete unit.

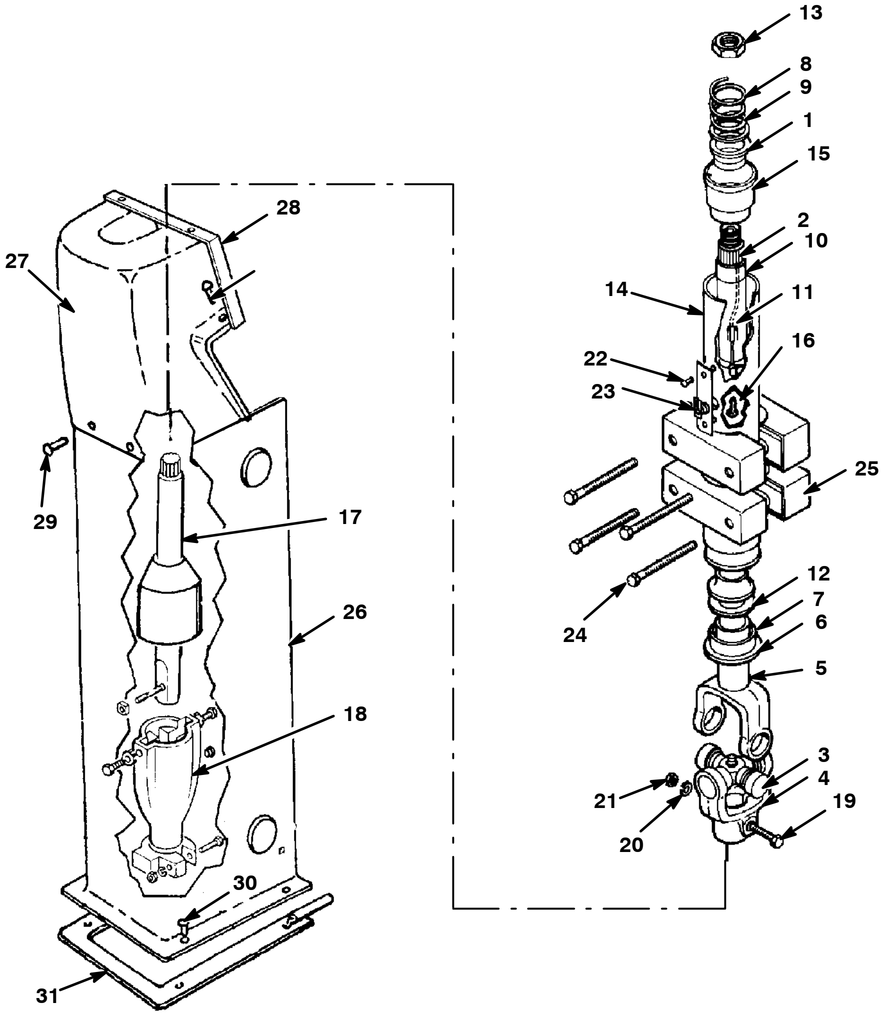
COLUMN DISASSEMBLY

When disassembling the fixed steering column, note the item reference numbers for the applicable steps of the procedure (Figure 3).

Fixed Steering

1. Unfasten and remove the steering wheel nut (13).

2. Remove the spring (8), washer (9), and spring seat spacer (1) from the top of the jacket tube and bearing assembly (14) & (15).



1.	SPACER
2.	WHEEL TUBE & SHAFT ASSY
3.	U–JOINT
4.	YOKE
5.	SPACER COLLAR
6.	FLATWASHER
7.	CUP WASHER
8.	SPRING
9.	WASHER
10.	CONTACT RING ASSY
11.	CABLE ASSEMBLY
12.	BUSHING – NYLON
13.	HEX NUT – MOUNT WHEEL
14.	TUBE
15.	BEARING
16.	SCREW
17.	LOWER SHAFT ASSY
18.	FLEXIBLE COUPLING
19.	CAPSCREW
20.	LOCKWASHER
21.	HUX NUT
22.	SCREW
23.	CONTACT BRUSH
24.	CAPSCREW
25.	U–CLAMP
26.	COVER S/A
27.	COVER – UPPER FRONT
28.	COVER – UPPER REAR
29.	SCREW
30.	SCREW
31.	SEAL

Figure 3. Fixed Steering Column

3. Remove the contact brush assembly (23) from the jacket tube. Slip the jacket tube (14), with upper/lower bearing assemblies (15) off the upper wheel shaft (2).

4. Unravel the tape on the contact ring (10). Disconnect the cable (11) from the contact ring and remove it from the wheel shaft.

5. Remove the nylon screw (16) that secures the contact ring to the upper wheel shaft and remove the contact ring.

6. Remove the lower nylon bushing (12), flatwasher (6) lower spacer, cup washer (7) and spacer collar (6) from the upper wheel shaft.

7. Remove the capscrew (19), hex nut (21), and lockwasher (20) from the lower yoke clamp and remove the lower shaft and U-joint assembly (3).

8. To disassemble the bearings, remove the retaining ring, retaining washer and felt washer. Separate the bearing halves and remove the rollers.

CAUTION

The bearing contains 20 rollers. If any of the rollers are lost or damaged, the entire bearing must be replaced.

Tilt/Telescoping Steering

When disassembling the tilt/telescoping steering column, note the item reference numbers for the applicable steps of the procedure (Figure 4).

WARNING

All steering mechanisms are safety critical items. It is imperative that these instructions be followed. Failure to observe the procedures and instructions may result in loss of steering. If inspection or testing revels evidence of abnormal wear or damage to the tilt column assembly or if you encounter circumstances not covered in the manual, -- STOP -- CONSULT TMC/MCI SERVICE DEPARTMENT. DO NOT TRY TO REPAIR OR SERVICE A TILT COLUMN ASSEMBLY WHICH HAS BEEN DAMAGED OR INCLUDES ANY PART THAT SHOWS EXCESSIVE WEAR UNLESS THE DAMAGED AND WORN PARTS ARE REPLACED WITH ORIGINAL REPLACEMENT AND SERVICE PARTS AND THE UNIT IS RESTORED TO SPECIFICATIONS.

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular Tilt Column Assembly to;

a. inspect the column for abnormal wear and damage,

b. choose a repair procedure which will not endanger his/her safety, the safety of others, the coach, or the safe operation of the coach, and

c. fully inspect and test the Tilt Column Assembly and the coach steering system to ensure that the repair or service of the column has been properly performed and that the column and steering system will function properly.

WARNING

The tilt column assembly has components under spring tension. the “tilt” and “telescoping” features should be in the “full up” position to minimize spring tension before removal from the vehicle or disassembly. wear eye protection and use caution to prevent injury.

WARNING

To prevent injury, use extreme care when using flammable cleaning solvents.

CAUTION

Do not allow the finish on the jacket tube outside diameter to be scratched, nicked or dented during assembly and disassembly as the finish is crucial to the telescoping action of the unit.

1. Remove the tilt and telescope lever (33), screw (25), spring cover plate (26), four screws (48) or two screws (48) and two screws (25), actuator housing (27), spring (28), actuator cam and pin assembly with cam (32), lock pin (29), pivot pin (31), and spring (30).

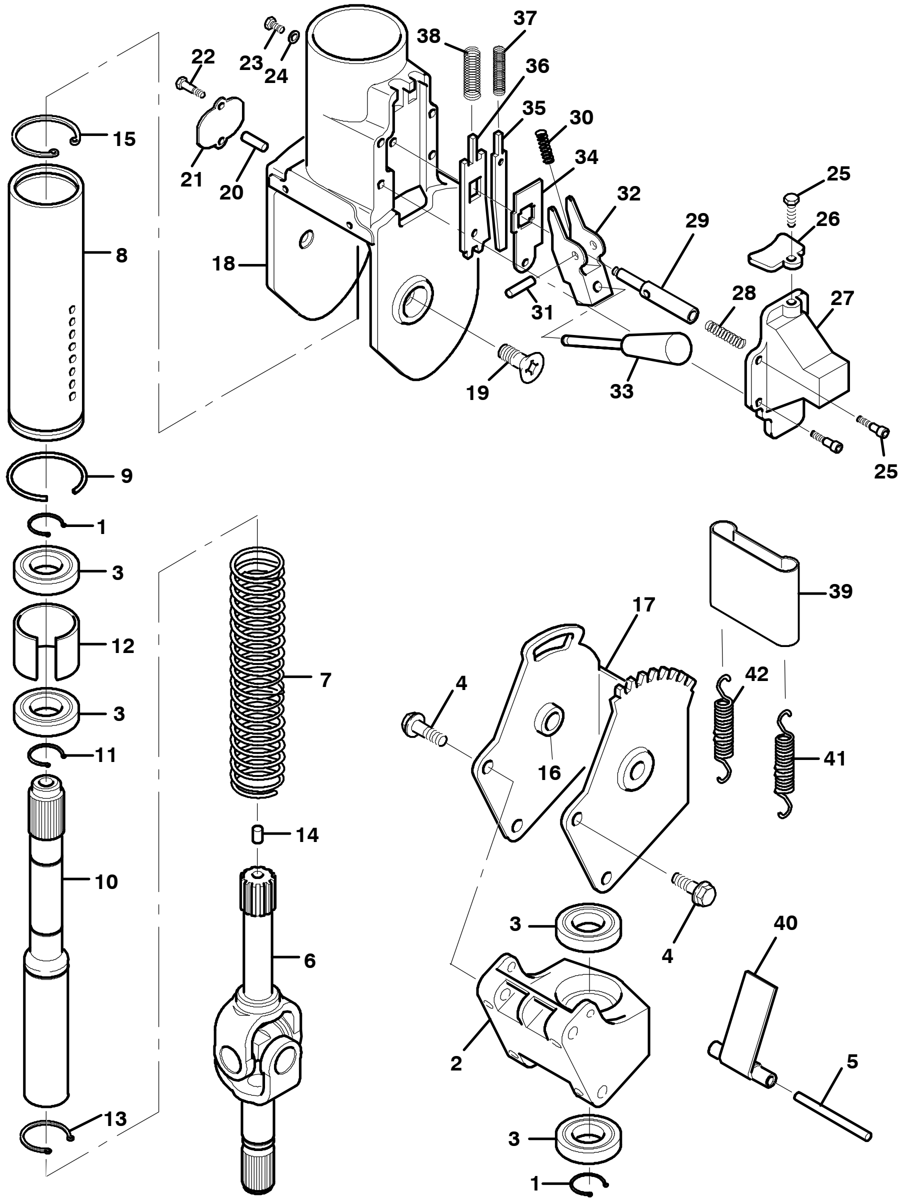
2. Remove disengaging plate (34), lockbar (36), spring (38), wedge lock (35), and spring (37).

3. Detach springs (41 and 42) from main housing (18). Remove upper spring cover (39).

4. Remove four screws (4) from support bracket (17) and lower housing (2).

WARNING

Be ready for the lower housing (2) and universal joint (6) assembly to eject under spring (7) tension from the main housing assembly.



1. RETAINING RING (2) – BOWED
2. LOWER BEARING HOUSING
3. BEARING (4)
4. SELF – TAPPING SCREW (4) 3/8–16 X 1.0 LG HX HD.
5. SPRING RETAINING ROD
6. UNIVERSAL JOINT ASSEMBLY
7. SPRING (EXTENDED)
8. JACKET TUBE
9. RETAINING RING
10. WHEEL TUBE & SLEEVE ASSEMBLY
11. RETAINING RING
12. BEARING SPACER
13. RETAINING RING
14. PIPE PLUG, 1/8 27 DRY SEAL SOCKET HD.
15. RETAINING RING
16. SET SCREW (2) 10–24 X 3/16 LG – SOC HD.
17. SUPPORT BRACKET
18. MAIN HOUSING ASSEMBLY
19. PIVOT SCREW (2) 1/2 20 X 1 1/8 LG SOC HD
20. TRAVEL STOP PIN (1 OR 2)
21. STOP COVER
22. SELF–TAPPING SCREW (2) 10–24 X 1/2 LG HX HD.
23. STOP SCREW – BOTTOM HD 5/16 18
24. INTERNAL TOOTH LOCKWASHER
25. SELF–TAPPING SCREW (1 OR 3) 10–24 X 5/8 LG
26. SPRING COVER PLATE
27. ACTUATOR HOUSING & BUSHING ASSEMBLY
28. SPRING–ACTUATOR HOUSING
29. LOCK PIN – TELESCOPE
30. SPRING–ANTI–RATTLE
31. PIVOT PIN
32. CAM–ACTUATOR
33. TILT & TELESCOPE LEVER
34. PLATE–DISENGAGING
35. WEDGELOCK
36. LOCK BAR
37. SPRING – WEDGELOCK
38. SPRING – LOCK BAR
39. SPRING COVER – UPPER
40. SPRING COVER – LOWER
41. SPRING R.H. (EXTEND) GREEN
42. SPRING L.H. (EXTEND)
    HORN CONTACT ASSY

7947

Figure 4. Tilt/Telescope Steering Column

5. Remove retaining ring (1) from the lower end of universal joint (6) and lower housing (2) assembly. Remove the universal joint assembly (6) from lower bearing housing (2). Remove bearings (3) from lower bearing housing only if the bearings are to be replaced. Suitable bearing puller required. Remove plug (14) from end of splined U-joint column if it is to be replaced. A 3⁄16-inch Allen wrench is required.

6. Remove the lower spring cover (40), springs (41 and 42) and spring retaining rod (5) from the lower bearing housing (2). Remove button head stop screw (23) and internal lockwasher (24) from main housing (18) assembly.

7. Push the wheel tube (10) and jacket tube (8) assembly out through the lower end of the main housing (18) assembly.

NOTE: If the jacket tube and wheel tube assembly are disassembled further, the two bearings (3) and retaining ring (11) in the jacket tube must be replaced because of the press fit and anaerobic locking agent used at assembly.

8. To remove the wheel tube and sleeve assembly (10) from the jacket tube (8), remove the retaining ring (1) from the top end of the wheel tube and retaining ring (15) from the jacket tube. Insert an 8-inch (20 cm) long x 3/4 inch (1.9 cm) diameter rod or tube into the splined sleeve end of the wheel tube and press out the wheel tube and bearing assembly while retaining the jacket tube. Do not scratch or nick the jacket tube finish.

9. Press the bearings (3) off of the wheel tube and splined sleeve assembly (10) using a suitable tubular bearing removal tool and discard bearings. Remove retaining ring (11) from wheel tube and discard.

10. If the support bracket (17) is to be removed from the main housing (18), first remove the two self-tapping screws (22), stop cover (21), and the one or two travel stop pins (20), from the main housing assembly. Note the letters of the holes with stop pins as they are removed.

11. Remove setscrews (16) from the two support bracket (17) nuts. Turn the two pivot screws (19) from the main housing assembly. Remove the support bracket from the main housing assembly (18). Clean off the Loctite applied to the threads in the nuts that are a integral part of the support bracket, the pivot screws and the setscrews.

NOTE: Applying heat to support bracket nuts with an electric heat gun or 1000-watt hair dryer will facilitate removal of setscrews and pivot screws that were attached with Loctite at assembly. Using appropriate size dies on setscrews. Pivot screws and taps on support bracket nuts, and a suitable solvent will aid in removing Loctite applied at assembly.

⚠ CAUTION ⚠

Do not exceed 500ºF (260ºC) or the material hardness may be affected.

Further disassembly of the main housing should not be made as the components cannot be serviced separately, and the collets and spring are staked into the housing. Replace damaged parts.

COLUMN ASSEMBLY

NOTE: Inspect the shaft splines, bearings, universal joint, and all threads for signs of wear or damage. Replace all parts not in good condition.

NOTE: Jack the bearings with clean grease and apply grease to the upper wheel shaft for the nylon bushings. Saturate the felt washers with No. 50 oil. Pack the bottom of the flexible coupling with 1 oz. (30 g) of heavy grease.

Fixed Steering

1. Assemble the upper wheel shaft U-joint assembly (3) onto the lower clamping yoke (4) and upper shaft yoke (2).

2. Tighten the capscrew (19), lockwasher (20) and hex nut (21) on the yoke clamp to 25-30 ft-lbs (34-41 N·m).

3. Assemble onto the upper wheel shaft the spacer collar (5), flatwasher (4), cup washer (5), internal spacer, flatwasher, nylon bushing (12) and lower bearing assembly.

4. Install the contact ring assembly (10) and connect the cable (11). Secure the cable to the contact ring with tape.

5. Slide the jacket tube (14) onto the wheel shaft (2) and install the contact brush assembly (23).

6. Install the upper bearing (15), spring seat spacer (1), flatwasher (9) and spring (8) onto the jacket tube.

NOTE: When assembling bearings onto the jacket tube, it may be necessary to tap the top of the tube with a rubber mallet.

Tilt/Telescoping Steering

1. Assemble the support bracket (17) into the main housing (18) sub-assembly so that the support bracket teeth are on the cam-actuator (32) side of the housing and the pivot screw holes are aligned. Turn the two pivot screws (19) loosely into the assembly.

2. Place a ½-inch diameter by 3-inch long bolt and nut assembly between the support bracket flanges, close to the bracket nuts, as a tool to spread the support bracket flanges. Begin backing the nut off of the ½-inch diameter bolt to spread the bracket flange bosses against the main housing and to provide clearance for the lower bearing housing (2) when assembled into the support bracket.

3. Remove the pivot screws. Add Lithium grease to taper under pivot head screws. Add Loctite RC680 to threads of pivot screws and two setscrews (16). Reassemble pivot screws into main housing and support bracket assembly.

4. Torque the pivot screw on the actuator cam side and then the other pivot screw to 50-60 in-lbs (5.6-6.8 N·m). Torque setscrews (16) into the bracket nuts to 15-25 in-lbs (1.7-2.8 N·m).

⚠ **CAUTION** ⚠

Do not get grease on screw threads or Loctite on screw head.

5. Assemble retaining rings (13 and 11) onto the wheel tube and splined sleeve assembly (10). Apply Loctite RC680 evenly around wheel tube on the lower bearing support area and push **new** lower bearing (3) onto the wheel tube and against retaining ring (11).

6. Apply Loctite evenly around wheel tube at the upper bearing support area, assemble bearing spacer (12) and push **new** upper bearing (3) onto the wheel tube until it clears the upper retaining ring groove. Assemble bowed retaining ring (1).

7. Press the wheel tube, sleeve and bearings as assembled into the jacket tube (8) end that has the counter bore and internal retaining ring groove until the upper bearing (3) is beyond the retaining ring groove. A tubular bearing installer tool pressing against the upper bearing (3) outer race is required. The split in the bearing spacer (12) must be aligned with the screw hole in the top end of the jacket tube to allow later assembly of bolt (43). Assemble retaining rings (9 and 15) in their grooves on the jacket tube.

8. To assemble the wheel tube and jacket tube assembly into the main housing assembly (18), place the jacket tube end down on a pedestal about 4 inches (101.6 mm) high x 2¼ inches (57.2 mm) in diameter. Be sure the cutouts of the lower collet in the main housing assembly (18) align with the holes for lock pin (29) and stop screw (23). Be sure the ends of the spring in the housing are approximately 90 degrees from the splits in the collets. This will facilitate assembly of the jacket tube in the housing. Assemble the main housing down over the jacket tube such that the jacket tube will enter the housing bore lower collet. As the upper end of the jacket approaches the upper tapered collet, the collet must be pushed down with a screwdriver or a suitable tool that will pilot over the wheel tube and into the housing bore. This will allow the jacket tube assembly to be pushed through the upper collets.

9. Align the jacket tube guide slot with the stop screw hole in the main housing assembly (18) and torque the button stop screw (23) and internal tooth lockwasher (24) into the stop screw hole to 15-20 ft-lbs (20.3-27.1 N·m)

10. If the bearings were removed, press a **new** bearing (3) into each counter bore in the lower bearing housing (2).

11. Assemble the lower serrated shaft of the universal joint assembly (6) into the lower bearing housing assembly (2) until it is seated against a bearing (3). Assemble retaining ring (1) onto the universal joint shaft. Turn ⅛-inch pipe plug (14) finger tight into the tapped hole in the slotted end of the U-joint shaft. Assemble the spring retaining rod (5) into the bearing housing (2).

⚠ **CAUTION** ⚠

If the pipe plug is tightened such that the end of the U-joint shaft is spread open, the shaft may not assemble into the spline sleeve as required.

12. Place the assembled main housing assembly (18), vertical in a soft jawed vise, clamp firmly against the serrate end of the wheel tube assembly (10). As an alternative the steering wheel can be set on the wheel tube as a holding fixture and the unit set upside down on a bench for these procedures. Push the wheel tube and jacket to full-down position in the main housing.

13. Assemble spring (7) over the lower end of the wheel tube and splined sleeve assembly. Assemble the universal joint (6) splined shaft into spring (7) and into the splined sleeve so that a slot in the splined shaft aligns with the wide flute in the mating splined sleeve. Two fingers in the lower U-joint shaft yoke will help guide the shaft into the splined sleeve. Push the universal joint assembly and lower housing (2) into the main housing (18) assembly and align the screw holes in the support bracket (17) with the holes in the lower housing.

14. While holding the U-joint lower housing assembly in place, torque four self-tapping screws (4) into the support bracket (17) and lower housing (2) to 25-35 ft-lbs (33.9-47.5 N·m)

CAUTION

To ensure that the U-joint splined shaft assembly does not eject from the splined sleeve, it must be held in position until at least an upper and lower screw are in place.

15. Lightly grease and assemble lockbar (36) onto main housing (18) with the locating pin up and engaging the teeth with the support bracket (17) teeth. Assemble spring (38) on end of lockbar.

16. Lightly grease and assemble wedge lock (35) next to lockbar with tapered end toward the support bracket teeth and the locating pin up. Assemble spring (37) onto end of wedge block.

17. Lightly grease and assemble disengaging plate (34) with the tabs up, over the lockbar (36) and wedge lock (35) locating pins.

18. If disassembled, assemble lock pin (29) into actuator cam (32) with spring hole in cam and lock pin facing each other, and press pivot pin (31) into its hole in the lock pin and actuator cam until it is flush to 0.015 inches (0.381 mm) below the actuator cam. Insert end of spring (30) into hole in lock pin, then the other end in actuator cam spring hole. Grease and insert lock pin assembly into its bushing in the main housing assembly (18) with actuator cam ears over the disengaging plate (34) raised tabs.

CAUTION

Use care that spring (30) does not eject from assembly.

19. Assemble spring (28) into top of lock pin and assemble actuator housing (27) over Actuator and pin assembly. Torque four attaching screws (45) to 40-60 in-lbs (4.5-6.8 N·m) into actuator and main housings, while holding actuator housing firmly down. Two screws (45) and two shorter (⅝) screws (25) are used on some units.

20. Assemble spring cover plate (26) over springs (37 and 38) and firmly hold in position while turning in screw to 40-60 in-lbs (4.5-6.8 N·m).

21. Assemble tilt and telescope lever (33) into actuator cam (32).

22. Tilt and telescope jacket and wheel tube assembly to "full up" position to facilitate spring assembly. While looking down from steering wheel end of the assembly, hook the end of green, right-hand coil spring (41) on the right side of spring retaining rod (5) and left-hand coil spring (42) on the left side. Snap the lower spring cover (40) on the retaining rod between the springs. Assemble upper spring cover (39) over the two springs engaging the lower cover in slot provided. Tilt jacket tube and wheel tube assembly to full down position. Hook the loose end of springs in holes in main housing using suitable spring assembly tool.

23. If removed, insert the one or two travel stop pins (20) in the lettered holes they were removed from as noted at disassembly.

24. Attach stop cover (21) with two self-tapping screws (22) torqued to 40-60 in-lbs (4.5-6.8 N·m).

25. Push telescoping jacket tube and wheel tube assembly all the way in and turn the ⅛-inch pipe plug (14) into the universal joint slotted shaft, enough to retain the jacket tube and wheel tube position when the telescoping lockpin (29) is disengaged. Then loosen the ⅛-inch pipe plug just enough to allow jacket tube and wheel tube assembly (about ⅛ turn) to telescope freely under spring tension. A ⅜-inch Allen T-bar wrench of suitable diameter and length [0.375 inches (9.52) diameter x 12 inches (304.8 mm) long] to reach the pipe plug down through the wheel tube is needed.

When the tilt and telescope lever (33) is held in the "up" position, the jacket and wheel tube assembly must be able to **telescope** to "full up" and "full down" position. When the tilt lever is held in the "down" position, the jacket and wheel tube assembly must be able to tilt to the "full up" and "full down" position. When the tilt lever is released, the tilt lever must return to the lock position and maintain the telescope and tilt position of the jacket and wheel tube at which the lever was released.

The tilt/telescoping column assembly is now complete except for a wheel nut (49) to be assembled at installation. The assembly should sit for 24 hours at room temperature before being put into normal use to allow the applied Loctite to set up.

COLUMN INSTALLATION

CAUTION

When installing the steering column, make sure no debris is around the lower column section where the it passes through the floor board. Debris left here can cause the steering column to bind. Proper installation of the steering column covers and closing seals will keep any debris from interfering with steering function.

Fixed Steering

1. Position the U-clamps around the jacket tube and align the tapping plate holes with the U-clamps. Thread the bolts into the tapping plate, but do not tighten.

2. Install lower shaft and U-joint assembly onto the steering gear input shaft. Center input shaft as outlined in sub-section 11D. Align the lower shaft serrations with the steering gear's input shaft. Insert bolt (20). Tighten nut (22) and lockwasher (21) to 25-30 ft-lbs (34-41 N·m) torque (Figure 5).

3. Align and tighten the bolts on the U-clamps.

4. Slide the turn signal assembly over the steering column, but do not secure.

5. Clean, degrease and apply "Locquic Primer T" to the column shaft threads and nut. Apply a film of "Loctite Stud Lock" to the shaft and nut. Mount the steering wheel in a straight-ahead position and install the wheel nut and tighten to 55-65 ft-lbs (75-78 N·m) torque.

6. Adjust and secure the turn signal assembly ensuring that it functions properly.

7. Install the contact brush wire on the left side of the steering column and connect the horn wires. Mount the steering wheel medallion ensuring that the logo is parallel and centered in the steering wheel crossmember.

8. Install the instrument panel and lower steering column cover.

TORQUE CHART

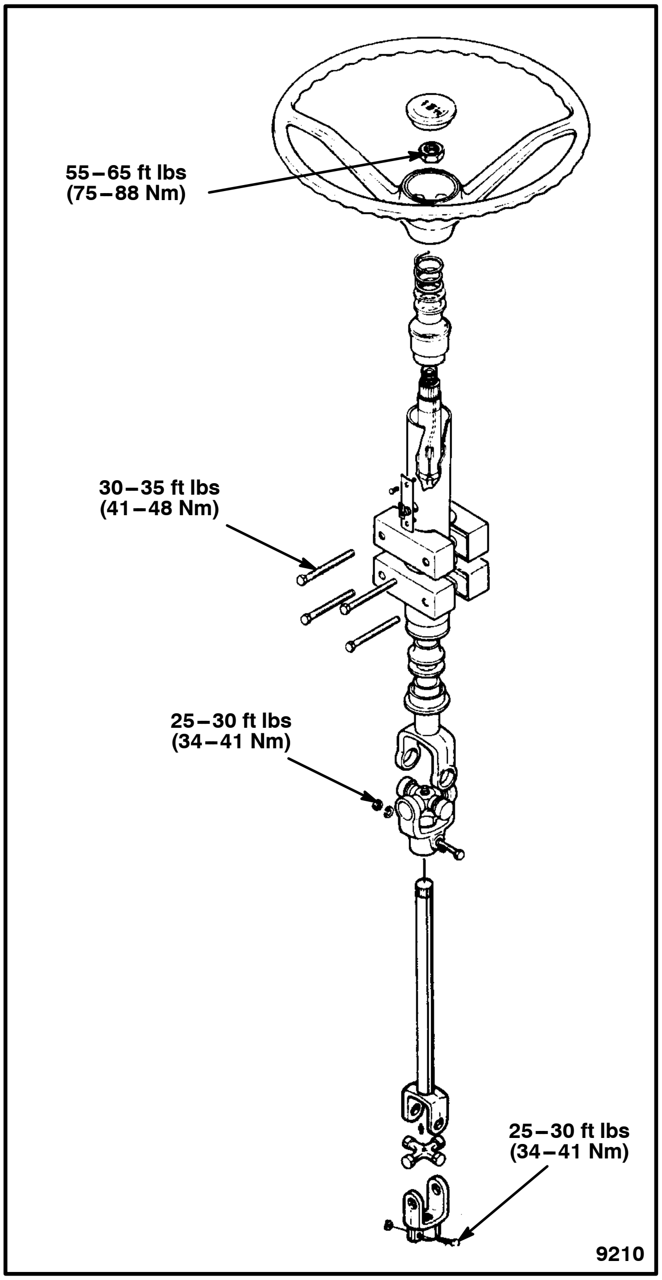

55−65 ft lbs
(75−88 Nm)
30−35 ft lbs
(41−48 Nm)
25−30 ft lbs
(34−41 Nm)
25−30 ft lbs
(34−41 Nm)
9210

Figure 5. Torque Chart

SPECIFICATIONS

STEERING COLUMN

Manufacturer	Ross Gear Division/TRW
Part Number	(Fixed Steering) 11L-2-14
Part Number	(Tilt/Telescoping Steering) 11L-2-98

STEERING WHEEL

Manufacturer	MCI
Part Number	11J-2-26

TURN SIGNAL SWITCH ASSEMBLY- (12-VOLT SYSTEM)

Manufacture	MCI
Part Number	(Fixed Steering) 7J-8-420
Part Number	(Tilt/Telescoping Steering) 7L-8-196

HORN SWITCH ASSEMBLY- (12-VOLT SYSTEM)

Manufacture	Vehicle Products
Part Number	11J-2-27

SECTION 11C

POWER STEERING PUMP

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GENERAL DESCRIPTION

Two slightly different power steering pump installations, depending on the engines that are specified, are used in the D series coaches. The 8V-92 is fitted with the VTM42 series (Figure 1) while the series 60 utilizes the VT73 series design. Both pumps supply approximately the same amount of hydraulic fluid for operation of the power steering gear.

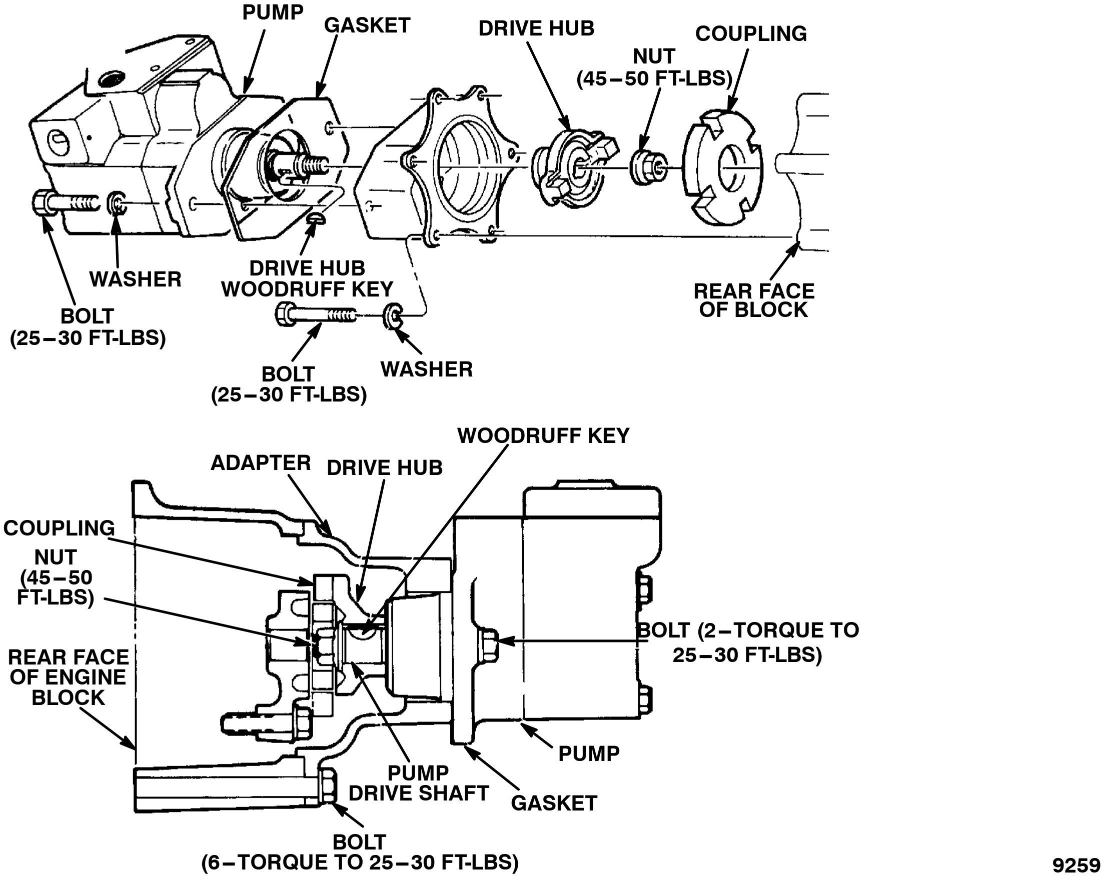

PUMP
GASKET
DRIVE HUB
COUPLING
NUT
(45–50 FT-LBS)
WASHER
DRIVE HUB
WOODRUFF KEY
REAR FACE
OF BLOCK
BOLT
(25–30 FT-LBS)
BOLT
(25–30 FT-LBS)
WASHER
WOODRUFF KEY
ADAPTER
DRIVE HUB
COUPLING
NUT
(45–50
FT-LBS)
REAR FACE
OF ENGINE
BLOCK
BOLT (2–TORQUE TO
25–30 FT-LBS)
PUMP
PUMP
DRIVE SHAFT
GASKET
BOLT
(6–TORQUE TO 25–30 FT-LBS)
9259

Figure 1. Power Steering Pump and Drive VTM42

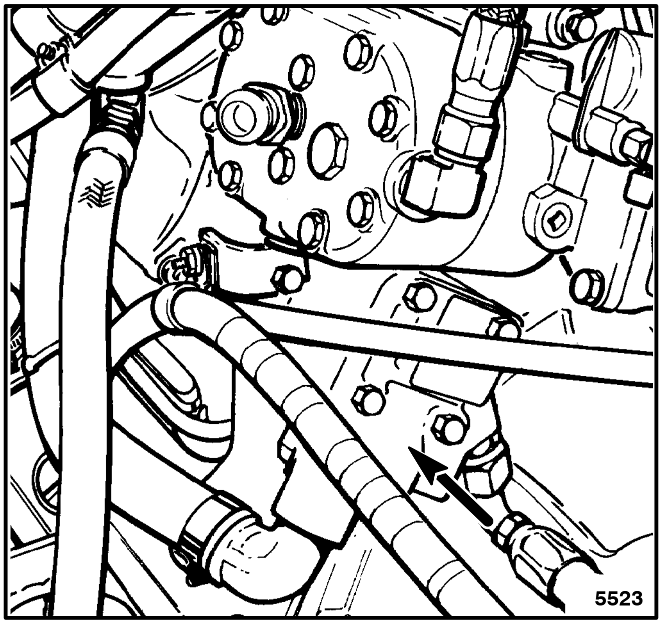
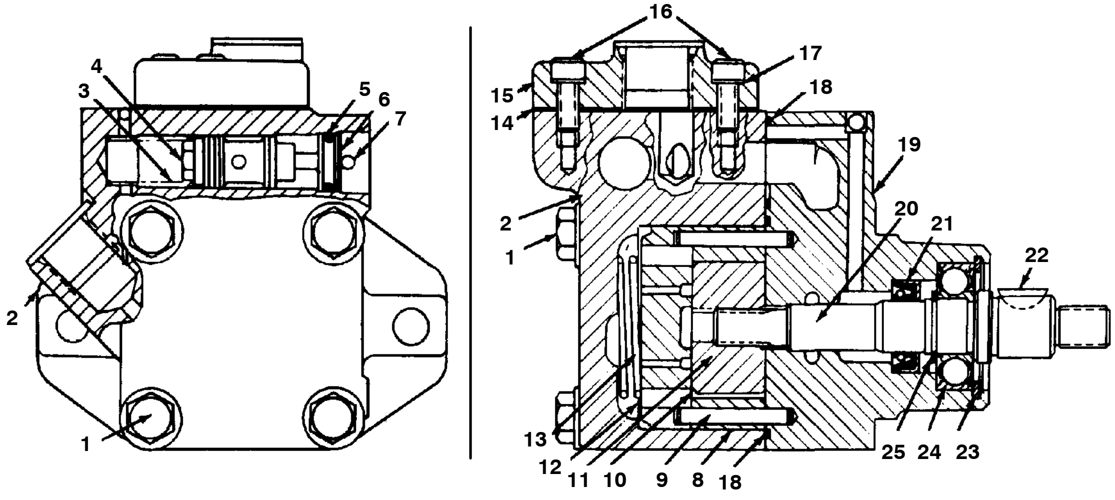


Figure 2. Hydraulic Pump Installation VTM42

The VT73 is gear driven, via a splined integral shaft, and mounted on the front gearcase housing. The VTM42 is also gear driven, but utilizes a drive hub and coupling encased in an adapter mounted to the rear flywheel housing (Figure 2). Both pumps are of a balanced vane type and have a constant rate of delivery per revolution. Pump ratings are 4 USGPM (15.2 liters) at 1500 RPM delivering100 PSI pressure. The maximum pump relief pressure is 1500 psi (10,350 kPa), (2000 psi) when a wheelchair lift is installed.

COMPONENTS

Both pumps are connected to a remote reservoir located in the return line's circuit. Principle components of the VTM-42 model pump proper consist of the housing, mounting flange, pumping cartridge, pressure/wear plates, control valve and drive shaft (Figure 3). These same components exist in the VT-73 model pumps, but none of them are serviceable (Figure 4).



1. Capscrew
2. Cover
3. Flow Control Spring
4. Relief Valve
5. O-Ring
6. Relief Valve Plug
7. Retaining Pin
8. Pump Ring
9. Locating Pins
10. Vane
11. Rotor
12. Pressure Plate
13. Pressure Plate Spring
14. Manifold Gasket
15. Manifold
16. Manifold Capscrew
17. Copper Washer (1 only)
18. O-Rings
19. Pump Body
20. Pump Shaft
21. Pump Shaft Seal
22. Woodruff Key
23. Retaining Ring
24. Ball Bearing
25. Retaining Ring

Figure 3. Hydraulic Pump Assembly W/Manifold VTM42

PRESSURE/WEAR PLATES

The pressure/wear plates seal the pumping chamber. A light spring holds the pressure plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge and provides the proper running clearance for the rotor and vanes.

PUMPING CARTRIDGE

The pumping cartridge is composed of the cam ring, rotor and rotor vanes. The rotor is splined to the pump drive shaft and turns the rotor to produce pressurized fluid.

RELIEF VALVE

The relief valve regulates any overpressure condition that may arise inside the pump.

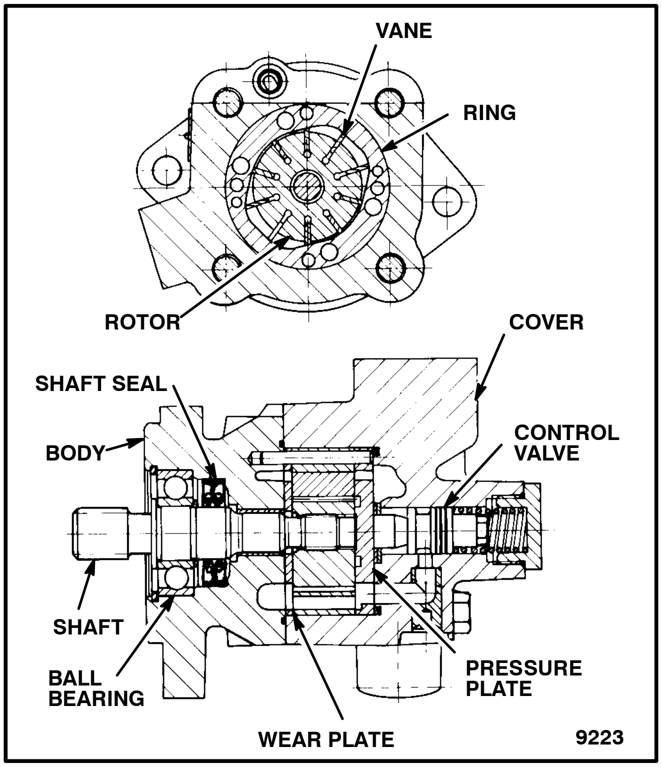


Figure 4. Power Steering Pump VT-73

OPERATION

NORMAL OPERATION

Fluid flow (Figure 5) is developed by the pumping cartridge. The rotor is driven within the cam ring by the drive shaft, which is coupled to the engine. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam ring. Radial movement of the vanes and turning of the rotor causes the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried past the large diameter or dwell section of the cam ring. As the outlet section is approched the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

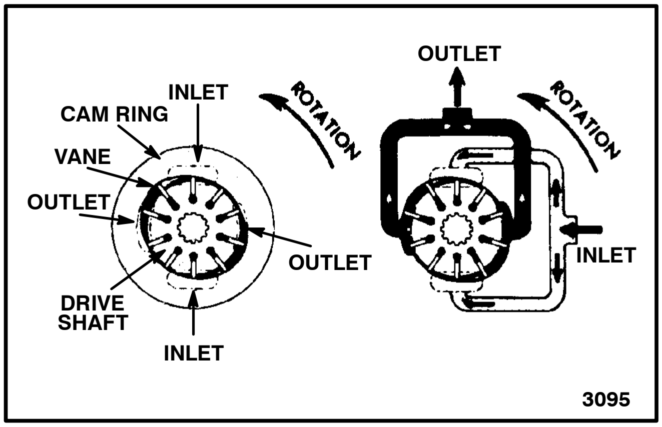


Figure 5. Fluid Flow

OVERPRESSURE OPERATION

An integral flow control relief valve subassembly limits pressure in the system to a prescribed maximum and protects the components from excessive pressure. The setting of the relief valve is preset at the factory and depends on the work requirements of the system. DO NOT try to readjust the relief valve in the field. The Pitman arm stops should be set to limit the degree that the Pitman can move in either direction. This prevents excessive thrust and cramping of the steering linkage which can cause excessive relief valve operation and overheat the pump.

At a volume greater than the rated flow, excess flow is by-passed to the inlet within the pump by the flow control valve. The flow control valve operates on pressure differential. The relief valve also operates on a pressure differential and limits the maximum pressure in the hydraulic circuit.

Maximum flow to the operating circuit and maximum system pressure is determined by the integral flow control and relief valve subassembly in a special outlet cover (Figure 6 and 7). An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to the reservoir, thus limiting the system pressure to a predetermined maximum.

Figure 6 shows the condition when the total pump delivery can be passed through the orifice. This condition usually occurs only at low speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure plus spring load in this chamber slightly exceeds pressure at the other end of the relief valve spool and the spool remains closed. Pump delivery is blocked from the tank port by the spool land.

When pump delivery is more than the flow rate determined by the orifice, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in figure 6.

If pressure in the system builds up to the relief valve setting figure 6, the pilot poppet is forced off its seat. Fluid in the light spring chamber flows through the spool and out to reservoir. This flow through the small sensing orifice, causes a pressure drop and prevents pressure in the light spring area from increasing beyond the relief valve setting. As pressure against the right end of the spool starts to exceed the relief valve setting, the pressure differential forces the spool to the left, against the light spring, porting the full pump flow to the reservoir.

DRIVE CONNECTION

The pumps are direct drive designs with the VT73 (series 60) driven via a splined input shaft off the front gears, and mounted on the front gearcase housing. The VTM42 (8V-92) is also gear driven, but utilizes a drive hub and coupling encased in an adapter mounted to the rear flywheel housing. Care should be taken when mounting the pumps to assure correct shaft alignment with the engine. A pilot on the pump mounting flange is provided to assure correct mounting. Make sure the pilot is firmly seated in the accessory opening of the engine. The gaskets should be installed carefully and lay flat. Shaft keys and couplings must be seated properly to avoid slipping and possible shearing.

HOSES AND TUBING

All hoses and tubing must be must be thoroughtly cleaned before installation. The number of bends in tubing are kept to a minimum to prevent excessive turbulance and friction of oil flow. Tubing or hoses must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the hose or tube.

HYDRAULIC FLUID RECOMMENDATIONS

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of oil should be made with the assistance od reputable supplier. Proper selection of oil assures satisfactory life and operation of system components.

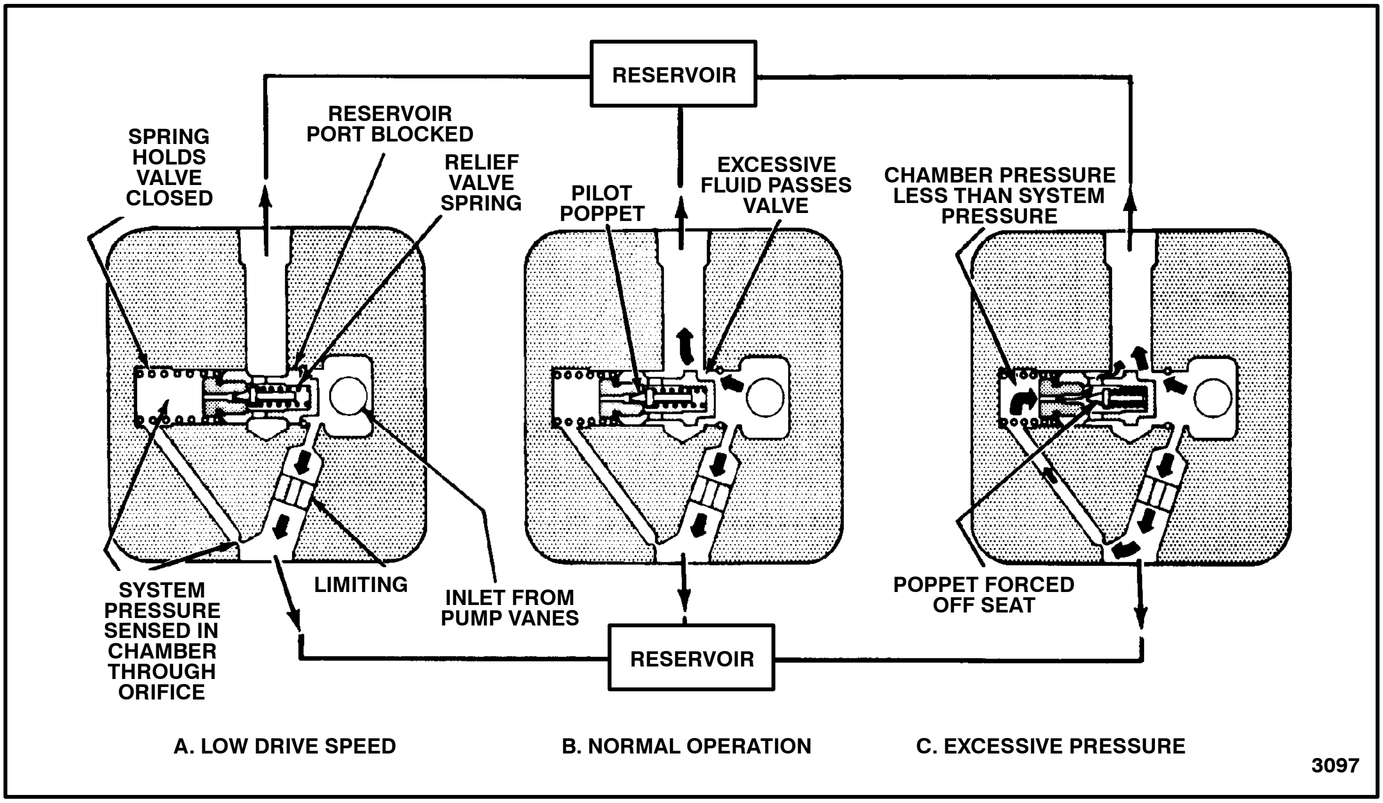
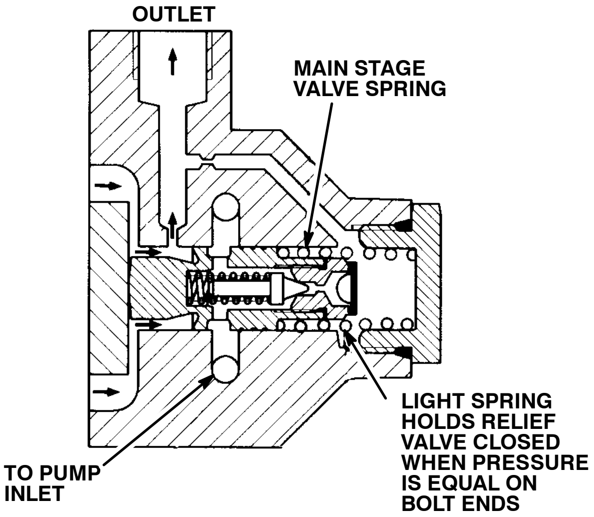
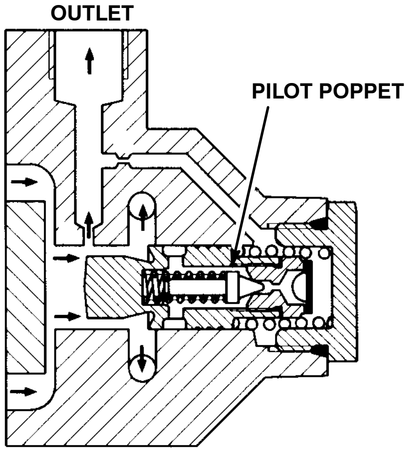

RESERVOIR
SPRING HOLDS VALVE CLOSED
RESERVOIR PORT BLOCKED
RELIEF VALVE SPRING
PILOT POPPET
EXCESSIVE FLUID PASSES VALVE
CHAMBER PRESSURE LESS THAN SYSTEM PRESSURE
SYSTEM PRESSURE SENSED IN CHAMBER THROUGH ORIFICE
LIMITING
INLET FROM PUMP VANES
RESERVOIR
POPPET FORCED OFF SEAT
A. LOW DRIVE SPEED
B. NORMAL OPERATION
C. EXCESSIVE PRESSURE
3097

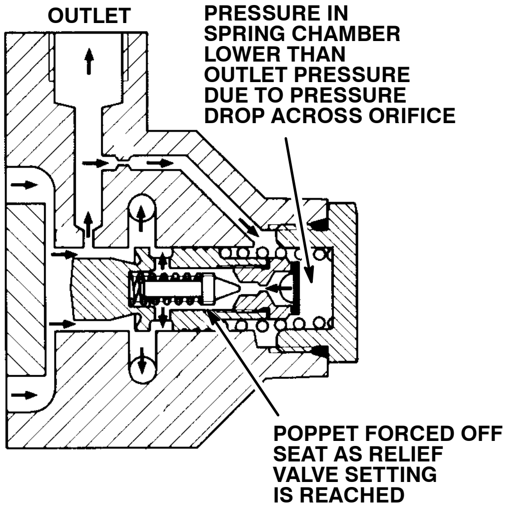
Figure 6. Hydraulic Pump Relief Valve VTM-42


OUTLET
MAIN STAGE VALVE SPRING
LIGHT SPRING HOLDS RELIEF VALVE CLOSED WHEN PRESSURE IS EQUAL ON BOLT ENDS
TO PUMP INLET

LOW DRIVE SPEED–ALL PUMP DELIVERY TO SYSTEM


OUTLET
PILOT POPPET

NORMAL OPERATION


OUTLET
PRESSURE IN SPRING CHAMBER LOWER THAN OUTLET PRESSURE DUE TO PRESSURE DROP ACROSS ORIFICE
POPPET FORCED OFF SEAT AS RELIEF VALVE SETTING IS REACHED

EXCESSIVE PRESSURE BUILD–UP IN SYSTEM

9225

Figure 7. Hydraulic Pump Relief Valve VT-73

CLEANLINESS

To ensure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of fluid to prevent introduction of contaminants into the system.
3. Provide continuous fluid filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Proper servicing of filters, breathers, reservoirs, etc. cannot be overemphasized.

SOUND LEVEL

Noise is indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at startup temperatures can cause pump noises due to cavitation.
2. Running with a moderately high viscosity fluid will slow the release of entrained air. The fluid will not be completely purged of air in the time it remains in the reservoir and will be recycled through the system.
3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similiar to cavitation.
4. Contaminated fluids can cause excessive wear of internal pump parts, which may result in increased sound levels.

STARTUP

With a minimum drive speed of 600 rpm, a pump should prime almost immediately, if provision is made to initially purge the air from the system. Failure to prime within a reasonable length of time may result in damage due to a lack of lubrication. Inlet lines must be tight and free from air leaks; however, it may be necessary to crack a fitting on the outlet side of the pump to purge entrapped air.

MAINTENANCE

ADDING FLUID

When hydraulic fluid is to be added, it should be poured through a fine wire screen (200 mesh or finer). The use of a cloth to strain the fluid should be avoided to prevent lint from getting into the system. The fluid must be clean and free of any substance which can cause any improper operation of the pump or other hydraulic units.

INSPECTION

Periodic inspection of the fluid condition and tube or hose connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid becomes too low and uncovers the inlet opening in the reservoir, extensive damage to the pump may result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the bypass to open, resulting in a partial or complete loss of filtration.

4. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the engine should be shutdown and the cause of the improper operation corrected.

TROUBLESHOOTING

Table 1 lists the common difficulties experienced with power steering pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually the failure of other components in the system. The cause of improper operation is best diagnosed with adequate testing equipment and thorough understanding of the complete hydraulic system.

REPACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if original manufacturer parts are used. Substitutes may result in early failure.

REMOVAL

The pump for 8V-92 installations is accessible through the right-hand engine compartment door, while the pump for series 60 installations is accessible through the rear motor doors. Follow the procedure in sequence.

WARNING

Before breaking a connection, make certain that power is off and system pressure has been released. plug all removed units and cap all lines to prevent entry of dirt into the system.

1. Turn battery switch to ”Off”.
2. Release all pressure in the power steering system.
3. Drain the reservoir.
4. Disconnect the hose fittings to the pump and plug holes to prevent any dirt from entering.
5. Remove the two mounting bolts holding pump mounting flange to either the 8V-92’s rear case adapter, or the series 60’s front gear case.

NOTE: The mounting flange gasket should be replaced whenever the pump is removed.

6. Remove the pump from the engine.
7. Reverse procedure for installation, and refill system per filling procedure.

DISASSEMBLY

In addition to a large work bench with vise, a parts cleaning tank and shop air, a clean work area is essential for hydraulic pump repair work.

NOTE: Any repairs to the hydraulic pump assembly should only be attempted and performed by trained hydraulic systems mechanics.

Lay clean paper on the work bench for disassembled parts. Place the parts in an orderly manner on the paper to avoid mixing the parts during assembly. Discard all O-rings and gaskets removed during disassembly.

NOTE: During the disassembly process special attention should be given to the identification and orientation of parts for proper reassembling.

Follow the steps of these procedures in the order in which they are presented. For item numbers referenced in each step refer to (Figures 8 and 9).

Model: VTM-42

1. Using a suitable cleaning solvent, thoroughly clean the exterior of the power steering pump to prevent entry of dirt or other foreign matter into the pump during overhaul procedures.
2. Clamp the pump body mounting flange (11) in a bench vise with protective jaws, housing end up.

3. Remove the three screws (24), copper washer (25), Manifold (26) and gasket (10) from cover subassembly (28).

4. Remove the four screws (22) from cover subassembly (28). Separate cover subassembly (28) from body (11). Remove spring (18) and pressure plate (17) from the body (11). Remove cam ring (15), pins (16), rotor (13), vanes (14), and two O-rings (7 and 8) from body (11).

5. Place cover subassembly (28) in bench vise.

6. Remove retaining ring (1) which holds bearing (4) within body (11). Press shaft (3) and bearing (4) from the body as a subassembly. DO NOT remove retaining ring (5) from shaft (3) unless bearing (4) is defective. The inner bearing (12) and shaft seal (6) are a press fit to the body. If defective, use a pin punch and hammer to tap them from the body (11). Remove shaft key (2) from shaft (3).

Model: VT-73 (Seal Replacement)

NOTE: Disassembly of the VT-73 model pump for any reason other than seal leakage should not be attempted. This series pump has no internal serviceable parts aside from the standard seal kit.

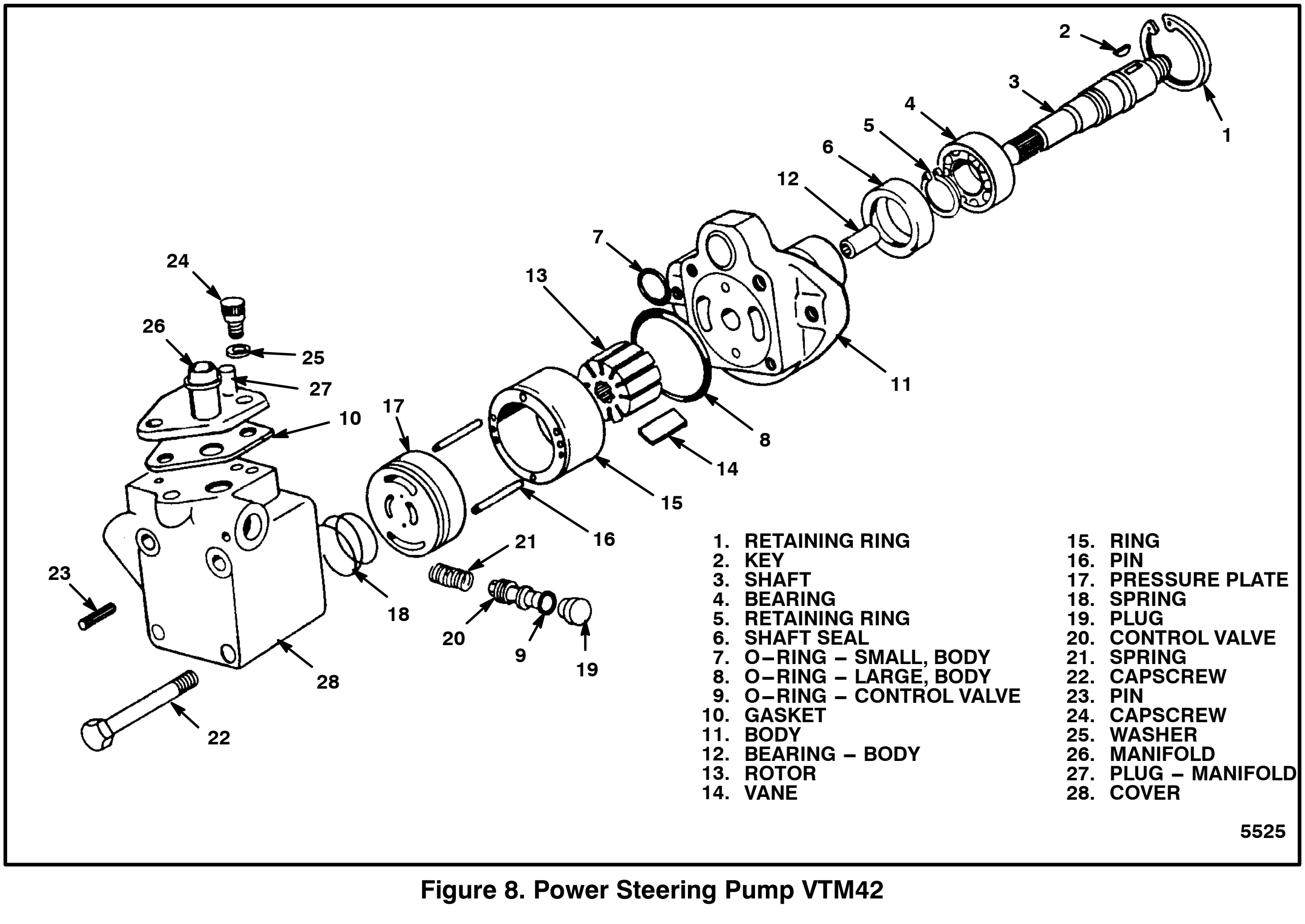
1. Clamp the pump body mounting flange (8) in a bench vise with protective jaws, housing end up.

2. Remove hex plug (23) from pump body, and gently remove spring (21) and control valve spool (20).

3. Unfasten and remove the housing retaining screws (24), and slide housing (19) off the shaft and pumping cartridge.

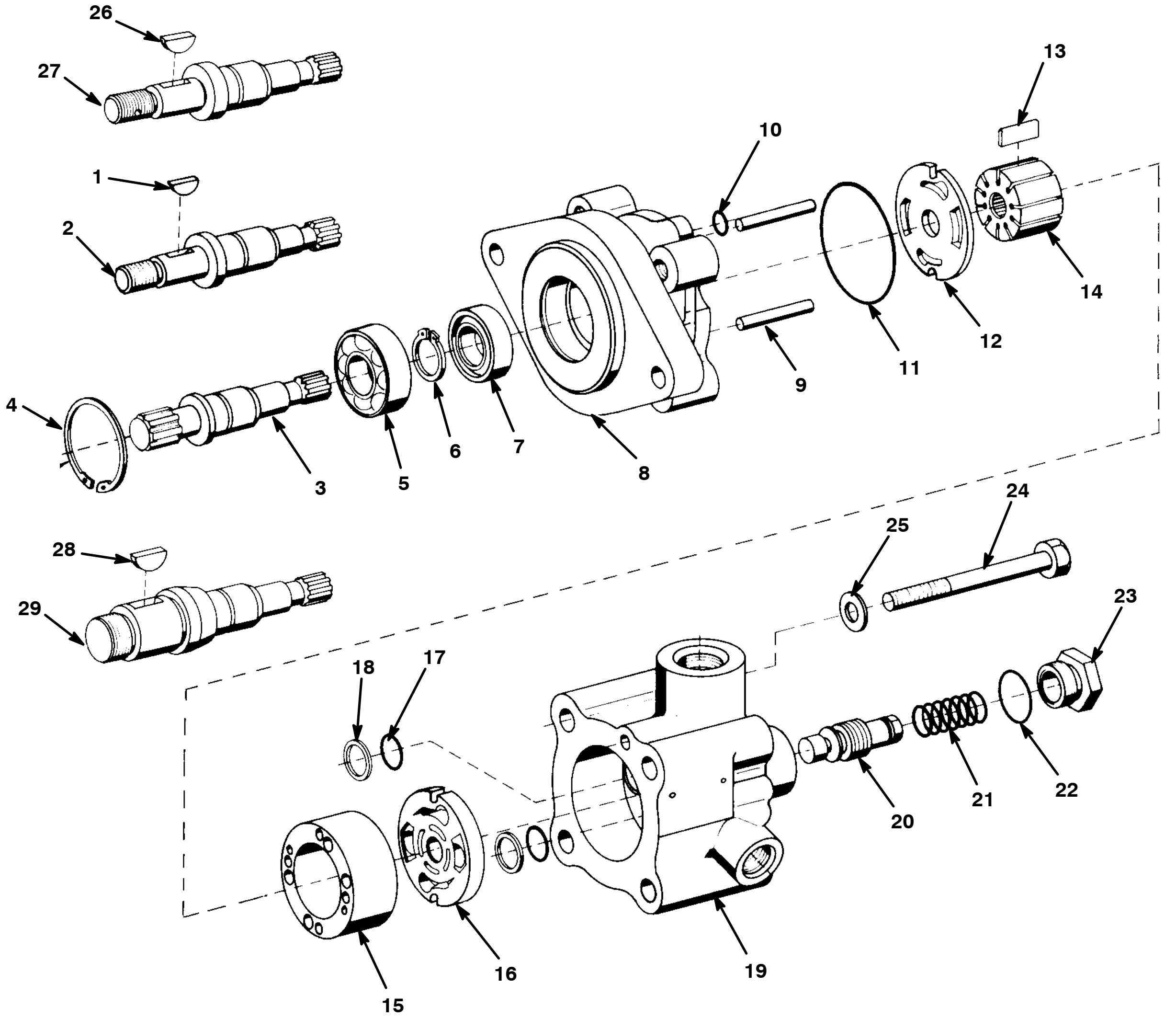
4. Remove the two O-rings (17) and back-up rings (18) from the pump housing interior.

5. Remove the pressure plate (16), pins (9), cam ring (15), rotor and vanes (13 & 14), wear plate (12) and flange O-rings (10 & 11).



1. RETAINING RING
2. KEY
3. SHAFT
4. BEARING
5. RETAINING RING
6. SHAFT SEAL
7. O–RING – SMALL, BODY
8. O–RING – LARGE, BODY
9. O–RING – CONTROL VALVE
10. GASKET
11. BODY
12. BEARING – BODY
13. ROTOR
14. VANE
15. RING
16. PIN
17. PRESSURE PLATE
18. SPRING
19. PLUG
20. CONTROL VALVE
21. SPRING
22. CAPSCREW
23. PIN
24. CAPSCREW
25. WASHER
26. MANIFOLD
27. PLUG – MANIFOLD
28. COVER

Figure 8. Power Steering Pump VTM42



ITEM	DESCRIPTION	QTY.
1.	WOODRUFF KEY	1
2.	SHAFT TYPE “73”	1
3.	SHAFT TYPE “38”	1
4.	SNAP RING	1
5.	BEARING	1
6.	SNAP RING	1
7.	SHAFT SEAL	1
8.	FLANGE S/A	1
9.	DOWEL PIN	2
10.	“O”–RING	1
11.	“O”–RING	1
12.	WEAR PLATE	1
13.	VANE KIT (10 VANES)	1
14.	ROTOR	1
15.	RING	1
16.	PRESSURE PLATE	1
17.	“O”–RING	2
18.	BACK–UP RING	2
19.	HOUSING	1
20.	CONTROL VALVE S/A	1
21.	SPRING	1
22.	“O”–RING	1
23.	PLUG	1
24.	SCREW	4
25.	WASHER	4
26.	WOODRUFF KEY	1
27.	SHAFT TYPE “03”	1
28.	WOODRUFF KEY	1
29.	SHAFT TYPE “00”	1

9226

Figure 9. Power Steering Pump VT-73

CLEANING AND INSPECTION

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerances of the parts makes this requirement more stringent than usual. Clean all removed parts in clean mineral spirits. Compressed air may be used in cleaning, but, it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices and cover passages.

NOTE: Any VT-73 series pump that fails inspection at steps 2 thru 5, 7 and 8 should be replaced.

1. Discard the used shaft seal and all O-rings. Wash the metal parts in clean mineral spirits, blow them dry

with filtered compressed air and place on a clean surface for inspection.

2. Check the wearing parts of the body, pressure plate, cam ring and rotor for scoring and wear. Replace scored or badly worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the vanes and rotor if the slots are worn. If side movement of the vanes in the rotor slots can be felt, the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races. Replace all defective bearings with new ones. Bearings must be replaced if removed.

5. Inspect the shaft seal mating surface on the shaft for scoring and wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Stone all mating surfaces of body and cover flange with an Arkansas stone to remove burrs and sharp edges (Steel). Polish out defects on aluminium alloy constructions. Re-wash and blow dry after stoning.

7. Visually check the control valve for wear (i.e. flat spots, etc.), and inspect the valve's housing bore for wear (i.e. scratches, etc.).

8. Lubricate and insert control valve into the housing bore. Rotate the control valve through 360 degrees while moving in and out of the bore to test for any binding.

NOTE: Control valve spool should slide gently inside bore. No binding should occur.

NOTE: Although the VTM-42 series pump offers a service replacement control valve assembly, evidence of bore wear would necessitate housing or pump replacement.

ASSEMBLY

Model: VTM-42

NOTE: Immerse all parts in clean hydraulic fluid to facilitate assembly.

NOTE: A tool for installing needle bearings can be made from round tubular stock with an outside diameter slightly smaller than the outside diameter of the bearing.

1. Starting with the pump body (11), press in the inner needle bearing (12) with an arbor press.

NOTE: The needle bearing must not be misaligned during press or the bearing will be damaged. DO NOT bottom out the needle bearing in its bore with excessive force. Check the rotor running surface of body subassembly (11) to be flat following assembly of the needle bearing.

2. Position shaft seal (6) with spring side facing body. Press seal in place until it engages the shoulder within the body.

⚠ CAUTION ⚠

This shoulder acts as a positive stop for the shaft seal. DO NOT over-press, or damage to the shaft seal will result.

NOTE: A tool for installing shaft seals can be made from round tubular stock with an outside diameter slightly smaller than the outside diameter of the seal and an inside diameter slightly larger than the shaft diameter. Do not score or damage the shaft (3) during this operation.

3. Press a new bearing (4) onto the shaft (3) with an arbor press.

NOTE: DO NOT exert pressing force against the outer race of the bearing. All force must be applied to the inner race of the bearing with a tubular tool. Do not score or damage the shaft (3) during this operation. The edge of the bearing must be $\frac{1}{64}$-inch (0.39 mm) below the shaft seal shoulder when assembled. This provides the shaft end play of 0.01-0.015 inches (0.254-0.381 mm)

4. Install the small retaining ring (5) in its groove on the shaft. The sharp edge of the retaining ring must be facing the bearing.

5. Lubricate the shaft with hydraulic fluid and slide the shaft assembly into the pump body (11). DO NOT damage shaft seal during installation.

6. Install the large retaining ring (1) into its groove in the pump body (11). This retaining ring holds the shaft subassembly in place in the pump body.

7. Insert the woodruff key (2) in the shaft, tap with a small hammer to seat the key.

8. Install the pump body (11) into the bench vise with the shaft end down.

9. Using the proper seal kit, Lubricate and install O-rings (7 and 8) into grooves as shown in Figure 8.

10. Insert vanes (14) into rotor (13) with radius edge toward the cam ring. Use an Arkansas stone on each vane edge and each rotor edge to remove any burrs developed during handling. Make sure the vanes do not bind within the rotor. Lubricate and place the rotor and vanes on top of the pump body (11) with the chamfered edge of the splined hole towards the pump body..

11. Insert pins (16) through the cam ring (15) and place the cam ring over the rotor and vanes. Position the arrow on the cam ring to agree with model code (R - clockwise rotation) as viewed from from the shaft end.

12. Install pressure plate (17) over pins and against the cam ring, rotor and vanes.

13. Place spring (18) on top of pressure plate (17), then install cover (28) over spring. Line up cover screw holes with body (11), thread the four screws (22) through the cover into the body (11). Cross torque screws to 25-30 ft-lbs (34-41 N·m).

14. Insert spring (21) into control valve bore of cover (28).

⚠ WARNING ⚠

In the following step if the flow control relief valve s/a is reversed in the cover bore, the unit will malfunction and pressure will rise dangerously high. Make sure that instructions are followed exactly as noted.

15. Install flow control relief valve (20) with the hex head going first into the bore. The hex headed seat plug must be located within spring (21). Lubricate and install a new O-ring (9) on plug (19) and slide plug into cover. Press plug fully in and insert tapered pin (23) to retain the plug in place. Tap the tapered pin in to lock in place.

16. Locate gasket (10) on cover manifold mounting surface.

17. Place manifold (26) over gasket (10) and align holes to cover.

18. Install copper washer (25) over screws (24) and thread screws into cover. Cross torque screws to 90-100 in-lbs (10-11 N·m)

19. Replace the pump on the engine.

NOTE: Make sure the hydraulic system is clean before installation of the rebuilt pump. Metallic debris of any type in the fluid will destroy the pump.

Model: VT-73 (Seal Replacement)

1. Place mounting flange and shaft sub-assembly back in vice with engine mounting face down.

2. Install small flange O-ring (10), and insert pins (9).

3. Install large flange O-ring (11), and position wear plate (12) on shaft with bronze coated side up.

4. Reinstall rotor and vane assembly (13 & 14) onto the shaft splines (3) with rotor's counterbore toward flange.

5. Place the cam ring (15) over the rotor and vane assembly.

⚠ CAUTION ⚠

Check the position of the arrow on the cam and make sure that direction is counterclockwise as viewed from the flanged end.

6. Position the pressure plate (16) over pins with bronze coated side towards rotor.

7. Using wheel bearing grease, position O-rings (17) and backing rings (18) into pump housing (19).

NOTE: The bearing grease is used to maintain the position of the rings when housing is positioned over pumping cartridge.

8. Install housing over the pumping cartridge and onto the mount flange, and insert the retaining screws (24) and washers (25). Torque screws to 29-37 ft-lbs (40-50 N·m).

9. Lubricate and install control valve (20) into housing bore, and insert spring (21).

NOTE: Control valve spool should slide gently inside bore.

10. Install new O-ring seal (22) onto the hex valve plug (23) and install on housing. Torque Plug to 33-40 ft-lbs. (45-55 N·m).

11. Test pump for any leakage if a test stand is available.

SPECIFICATIONS

POWER STEERING PUMP

Manufacturer	Vickers
Model	VTM-42-40-55-15-ME-R1-14-S4
Type	Vane
Rotation (Viewed From Shaft End)	Clockwise
Mounting Location	Rear Gear Case Housing
Maximum Output Pressure	1,500 psi (10,350 kPa)

POWER STEERING PUMP

Manufacturer	Luk International
Model	VT-73-21-16-100L-UUD-38-10
Type	Vane
Rotation (Viewed From Shaft End)	Counterclockwise
Mounting Location	Front Gear Case Housing
Maximum Output Pressure	1,500 psi (10,350 kPa)

ROTOR (VTM-42)

Width	0.7695-0.7693” (19.5453-19.5402 mm)
Outside Diameter	1.598-1.593” (40.589-40.262 mm)
No. Vane Slots	10
Vane Slot Width	0.0785-0.0780” (1.9939-1.9812 mm)

ROTOR VANES (VTM-42)

Quantity	10
Thickness	0.0775-0.0770” (1.9685-1.9558 mm)
Width	0.343” (8.712 mm)
Length	0.7692-0.7689” (19.5377-19.53 mm)

RELIEF SPRING (VTM-42)

Free Length	2.5468” (64.6887 mm)
Compressed Length	Under 6.25 lbs. - 1.2968” (2.84 kg-32.9387 mm) Under 8.20 lbs. - 0.9062” (3.72 kg-23.0175 mm)
Rate	5 lbs. (2.27 kg) per inch (25.4 mm)

SECTION 11D

STEERING GEAR TAS-85 SERIES

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 11D-1
Components 11D-1
Maintenance 11D-3
Torque Specifications 11D-7
Specifications 11D-7

GENERAL DESCRIPTION

Beginning with Unit #45465, the TAS-85 series steering gear will be used on the model D series coaches. This steering gear can be easily recognized by having only one (1) bottom relief valve screw,furnished loose with the assembly.

This integral power steering gear utilizes hydraulics to assist the manual steering mechanism's input, through its hydraulic control valve and power cylinder, effortlessly effect steering changes on the front axle 's steering geometry.

Force on the steering wheel is transmitted to the steering gear input shaft. The input is connected to worm shaft by means of a torsion bar. The torsion bar turns with the input shaft,exerting a rotational force on the worm shaft. The worm shaft in turn transmits the force through a ball nut mechanism to axial force on the rack piston. The rack piston resists this force due to its connection to the sector shafts load. With this resistance, torsion bar is twisted by the input shaft. Pressurized fluid moves the rack piston axially through the cylinder bore and overcomes the rack piston resistance and turns the sector shaft thereby steering the coach.

If the wheels receive a shock load, the shock force is transmitted through the sector shaft to the rack piston and on to the worm shaft. This force causes the control valve to send high pressure fluid to the proper cavity to resist the shock force. By hydraulically absorbing the shock, the steering gear prevents kickback at the steering wheel.

The control valve is a rotary type which directs oil flow from the engine driven power steering pump to either one of the power cylinder cavities. The flow directed to the power cylinder's cavity is dependent upon the speed at which the steering wheel is turned (Figure 1).

The steering gear is equipped with two unloading valves (poppets) at either end of the housing. As the steered wheels approach the axle stop, the corresponding poppet is opened. This reduces pressure in the gear and helps to reduce heat generated by the pump. The tripped poppet also reduces the load force on the steering linkage. These poppets may be adjusted by the adjusting screws on either end of the steering gear.

COMPONENTS

The steering gear is made up of several internal and external components (Figure 2). Most of the gear's internal components are addressed for disassembly, repair and reassembly in the manufacturer's service manual.

NOTE: Service manuals for the TAS-85 Series Steering Gears are available from:

MCI Service Control Center
P.O. Box 528
Pembina, N.D. 58271-0528
Telephone: (800) 241-2947

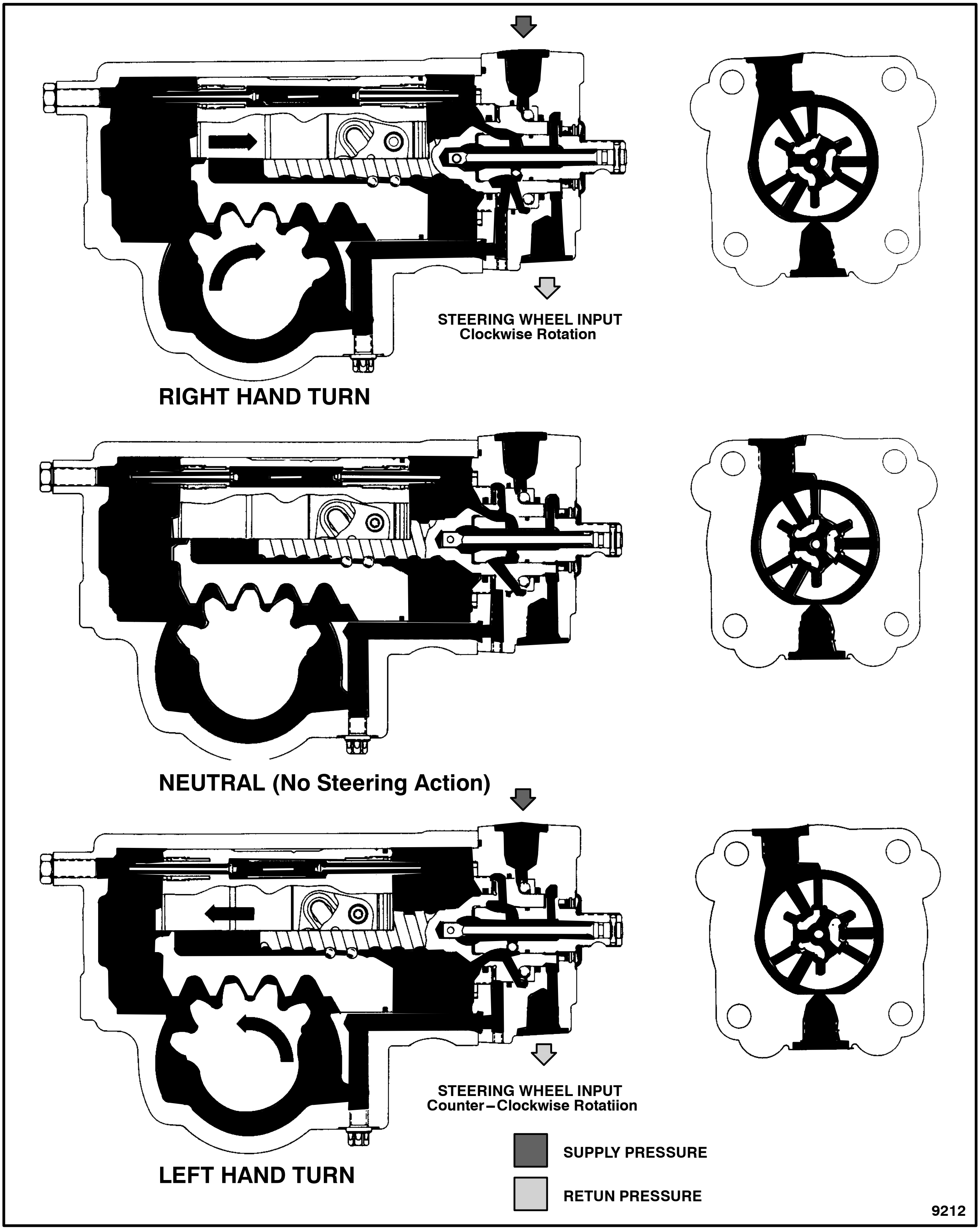

STEERING WHEEL INPUT
Clockwise Rotation
RIGHT HAND TURN
NEUTRAL (No Steering Action)
STEERING WHEEL INPUT
Counter–Clockwise Rotatiion
LEFT HAND TURN
SUPPLY PRESSURE
RETUN PRESSURE
9212

Figure 1. Steering Gear Oil Flow

The external and internal components that will be addressed in this section, for adjustment procedures only, are the input shaft, sector shaft, relief valve set screw and the steering gear housing.

MAINTENANCE

CENTERING STEERING

1. Center the steering gear housing on its mounting plate by aligning the sector shaft timing mark (scribed line) at a 90 degree angle to the input shaft.

> **NOTE:** The pitman arm is installed on the sector shafts so the timing marks on the arm and shaft are aligned so the arm is slightly (approximately 3 degrees) to the left of parallel with the coach centerline.

2. Adjust the drag link so that the wheels are straight ahead.
3. If necessary, remove the steering wheel and install it so that the cross pieces are at the 3 and 9 o'clock positions.

AXLE STOP ADJUSTMENT

1. Turn the wheels until there is a minimum 1/16 inch (1.59mm) clearance between the left tie rod arm and any possible contact surfaces.
2. Adjust axle stop screw to provide this clearance (Figure 3).
3. Turn the wheels to the right until there is a minimum 1/16 inch clearance between the right tie rod arm and any possible contact surfaces.
4. Adjust axle stop screw to provide this clearance.

RELIEF VALVE ADJUSTMENT

> **NOTE:** When a new steering gear is installed the valve adjusting screw (Figure 4), may be set all the way in. This causes hard steering to the left and right. The valve screws need to be adjusted before putting the coach into service.

1. Before adjusting the relief valve make sure the axle stops are properly set and the front wheels are on the floor.

> **NOTE:** See Service Bulletin No. 2596 for correct procedures.

2. Back off the adjusting screw jamnuts and turn the bottom relief screw all the way into the gear.
3. Start the engine and let it idle.

⚠ CAUTION ⚠

When relief pressure is reached, the gear will produce a hissing sound. This is normal, however, do not hold the gear in this position for longer than five seconds. To do so will damage the pump.

4. Tighten the jamnut to 12-18 ft-lbs (16.3-24.4 N·m) torque.

> **NOTE:** While tightening the jamnut, make sure that the adjusting screw does not move.

5. Check the clearance at the right-hand stop to ensure that it has not changed. If it has, readjust the poppet.

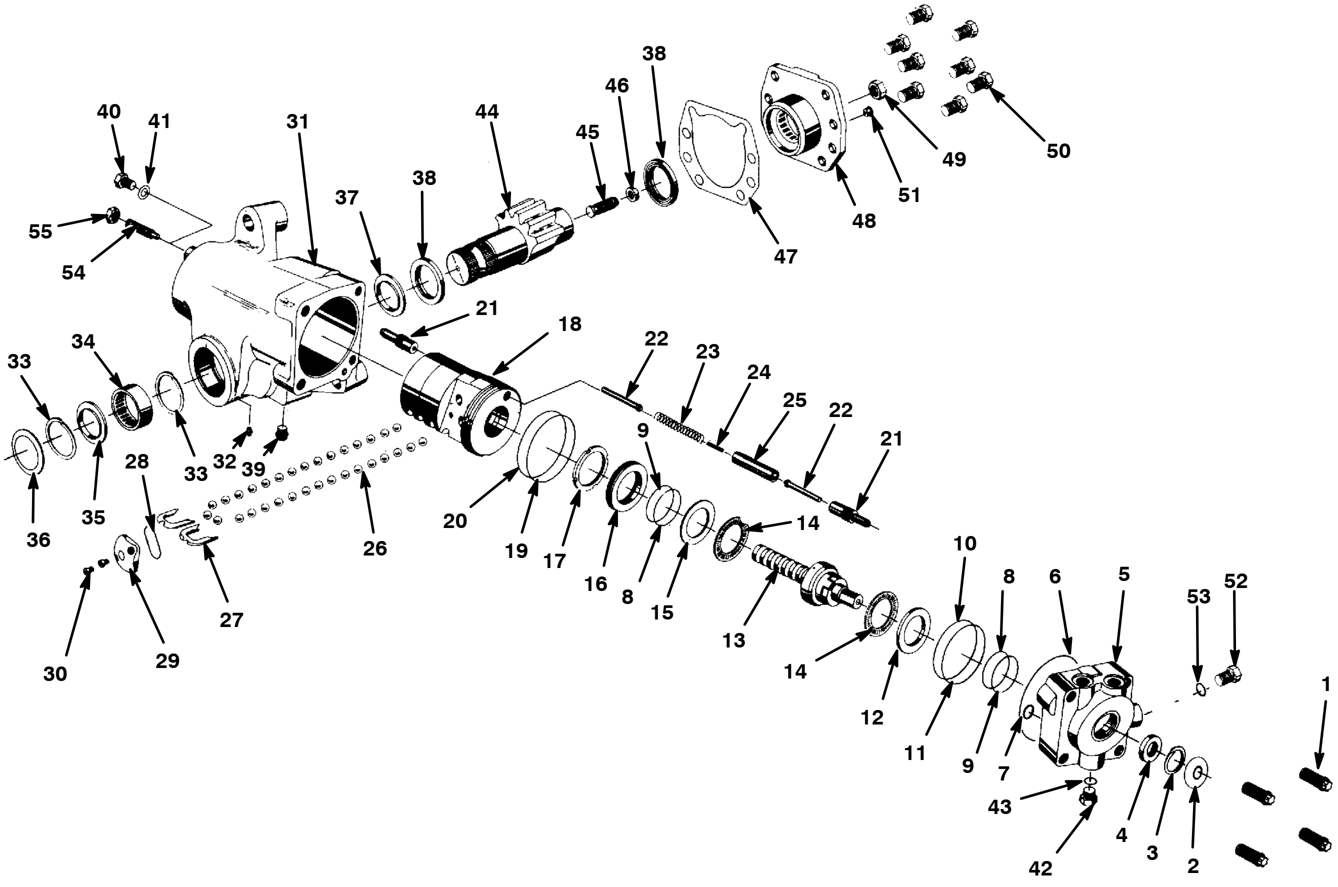
REMOVAL

1. Remove the steering column per removal procedure.
2. Unfasten and remove the drag link from the pitman arm.
3. Remove the pinch bolt on the pitman arm.
4. Drive a wedge into the groove at the top of the arm to loosen it from the sector shaft. Slide the pitman arm off the shaft.
5. Clean the area around the fittings.
6. Disconnect the hoses and plug the holes to prevent contamination.

⚠ WARNING ⚠

The steering gear weighs approximately 110 lbs. (50 kg) dry. Before continuing with the removal procedure, support the gear to prevent it from falling from the frame after the mounting bolts have been removed.

7. Take out the seven (7) bolts that hold the gear to the mounting plate and carefully remove the gear.



1	BOLTS (4–VALVE HOUSING)
2	DIRT AND WATER SEAL
3	RETAINING RING
4	SEAL (INPUT SHAFT)
5	VALVE HOUSING
6	SEAL RING (VALVE HOUSING)
7	SEAL RING (VALVE HOUSING)
8	SEAL RING (2)
9	0–RING (2)
10	SEAL RING
11	O–RING (VALVE HOUSING)
12	THRUST WASHER (THICK)
13	INPUT SHAFT, VALVE, WORM ASSY.
14	THRUST BEARING (2)
15	THRUST WASHER (THIN)
16	BEARING ADJUSTER
17	ADJUSTER LOCKNUT
18	RACK PISTON
19	TEFLON SEAL RING (RACK PISTON)
20	O–RING (BACK UP; RACK PISTON)
21	POPPET ADJUSTER SEAT AND SLEEVE ASSY. (2)
22	POPPET (2)
23	POPPET SPRING
24	SPACER ROD
25	PUSH TUBE
26	BALLS (34)
27	BALL RETURN GUIDE HALVES (2)
28	SEAL (CAP)
29	BALL RETURN GUIDE CAP
30	TORX SCREWS (2–CAP)
31	HOUSING
32	GREASE FITTING
33	RETAINING RING (2)
34	ROLLER BEARING
35	DIRT SEAL
36	DIRT AND WATER SEAL (TRUNNION)
37	WASHER (SPACER)
38	SEAL (2–OUTPUT)
39	PLUG (AUTO BLEED)
40	FIXED STOP SCREW (POPPET)
41	WASHER (STOP SCREW)
42	AUXILIARY PORT PLUG (2)
43	O–RING (2–AUX. PORT PLUG)
44	SECTOR SHAFT
45	ADJUSTING SCREW (SECTOR SHAFT)
46	RETAINER (ADJ. SCREW)
47	GASKET (SIDE COVER)
48	SIDE COVER AND BEARING ASSY.
49	JAM NUT
50	SPECIAL BOLTS (8–SIDE COVER)
51	VENT PLUG (SIDE COVER)
52	RELIEF VALVE CAP
53	O–RING (RELIEF VALVE)
54	SERVICE POPPET ADJUSTING SCREW
55	SERVICE SEALING JAM NUT

9218

Figure 2. Steering Gear

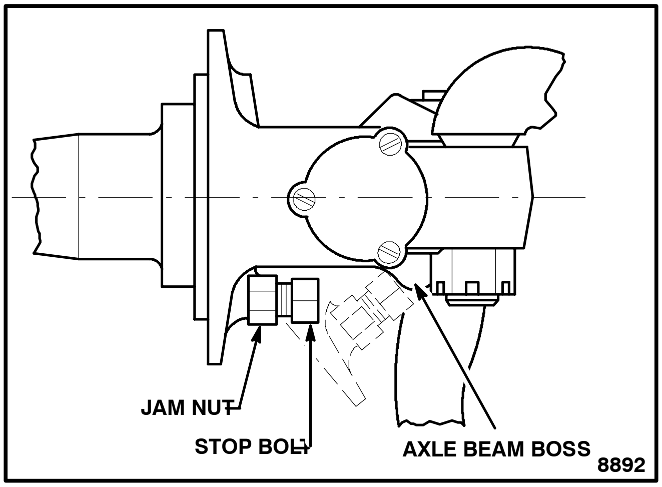


Figure 3. Stop Screw Adjustment

INSTALLATION

1. Align steering gear housing with mounting holes in undercarriage frame. Install bolts with hard steel washers and tighten the 7/8 inch bolt to 475-525 ft-lbs (644-712 N·m) torque. Tighten the 3/4 inch bolts to 295-325 ft-lbs (400-441 N·m) torque.

NOTE: See “Centering Steering” procedure earlier in this section.

2. Install Pitman arm on gear output shaft with alignment marks aligned. Tighten pitman arm hex nut to 310-320 ft-lbs (420-434 N·m) torque.

NOTE: To ensure against seizure of the pitman arm to the output shaft splines of the steering gear, apply Never-Seize to the output shaft splines prior to installing the pitman arm (Lubricant PN21-7512-7).

3. Attach drag link top pitman arm. Install end clamp bolt and tighten to 60-80 ft-lbs (81-108 N·m) torque.
4. Connect steering shaft to steering gear actuating shaft install clamp bolt with washer and nut. Tighten to 25-30 ft-lbs (34-41 N·m) torque.
5. Remove protective caps from power steering gear supply and return lines and connect the lines to the gear.
6. Connect height control valve link to mounting bracket. Raise coach to normal ride height and remove the spacers from the axle.
7. Check the fuel oil level in the hollow center axle. Replace any loss that occurred during power steering gear removal. The axle holds two quarts of fuel oil.
8. Fill the power steering reservoir. (Filling power steering system.)
9. Bleed the hydraulic system as directed under Bleeding Air from Power Steering System.

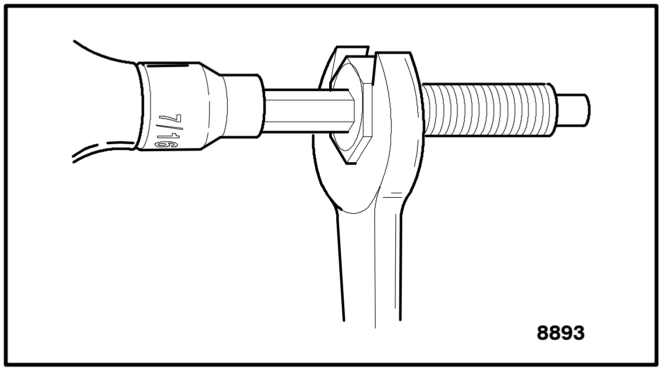


Figure 4. Relief Valve Adjustment

FILLING POWER STEERING SYSTEM

NOTE: For steps 1 and 2, do not turn the steering wheel. Otherwise, air will enter the system.

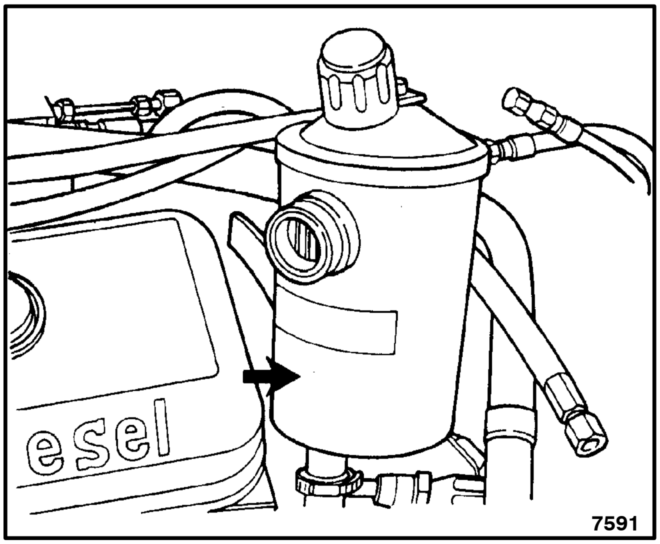


Figure 5. Power Steering Reservoir and Filter

1. Fill the reservoir nearly full (Figures 5 and 6). Crank the engine for 10 seconds without allowing it to start. If the engine does start, shut it off immediately.

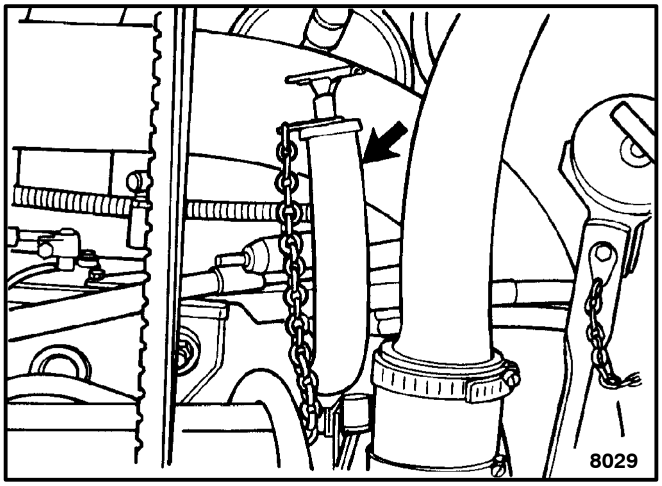


Figure 6. Power Steering Reservoir Fill

2. Check and refill the reservoir as necessary. Perform this procedure three times, each time checking and refilling the reservoir.

⚠ CAUTION ⚠

Do not allow the fluid to drop significantly or run out of the system. This will allow air into the system.

3. Start the engine and let it idle for two minutes, shut the engine off and check the fluid level in the reservoir.

4. Start the engine. Steer the coach from full left to full right several times.

5. Add fluid to reservoir until it reaches the halfway point in the sight glass.

BLEEDING AIR FROM POWER STEERING SYSTEM

NOTE: This procedure is to be followed any time the hydraulic loop has been opened, depending on what area has been worked on. The time to bleed the system could be considerably less than for a total system purge.

1. Ensure all power steering connections have been made and are properly tightened.

2. Add fluid (10W-40 oil) to reservoir and fill until oil is to bottom of fill spout in reservoir cover.

3. Start engine, but do not operate at higher than idle rpm.

4. At the instant the engine starts, oil level will drop in the reservoir as oil fills the supply line to the power steering gear. Oil must be continually added to ensure pump inlet is not allowed to starve or run dry.

5. When oil level stabilizes within the reservoir, the oil level should be brought to the sight glass level.

6. With the engine at idle speed, the steering wheel should be turned lock-to-lock at least six times. When all air is removed from the system, air bubbles will no longer surface through the oil in the reservoir. While air bubbles are still surfacing, it indicates that the system is not completely bled. In this case the steering wheel must continue to be cycled lock to lock and the oil level must be constantly monitored and oil replenished.

7. With the system fully bled, fill the reservoir to specified levels. Replace cap on reservoir.

TORQUE SPECIFICATIONS

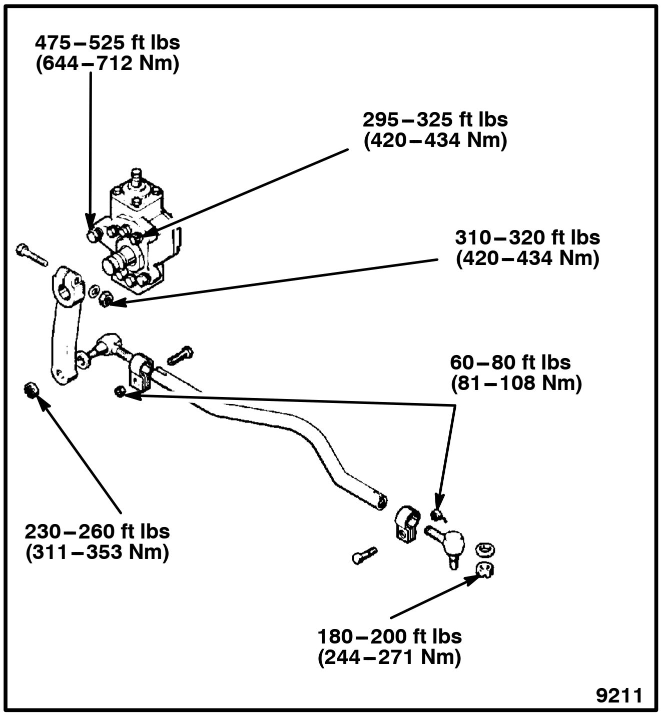

475–525 ft lbs
(644–712 Nm)
295–325 ft lbs
(420–434 Nm)
310–320 ft lbs
(420–434 Nm)
60–80 ft lbs
(81–108 Nm)
230–260 ft lbs
(311–353 Nm)
180–200 ft lbs
(244–271 Nm)
9211

Figure 7. Torque Chart

SPECIFICATIONS

INTEGRAL STEERING GEAR

Manufacturer	Ross Gear Division/TRW
Model	TAS-85029
Ratio	23.3:1
Type	Vane
Rotation	Clockwise (viewed from shaft end)
Location	Driver's Floor Frame
Maximum Output Pressure	2,000 psi (13,800 kPa)

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 12

SUSPENSION SYSTEM

This section consists of five primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The five primary subsections are:

A - Suspension Systems
B - Front Axle Suspension
C - Drive Axle Suspension
D - Trailing Axle Suspension
E - Suspension Control Systems

SECTION 12A

SUSPENSION SYSTEMS

CONTENTS OF THIS SECTION

SUBJECT **PAGE**
General Description 12A-1
Components 12A-1
Maintenance 12A-2

GENERAL DESCRIPTION

The D series coach suspensions utilize an air spring design to maintain the proper axle to chassis distance and desired ride. The front and rear axle suspensions are basically the same on all models of the D series. However, the trailing axle suspension on the 102D3 coach differs significantly from that of the 102DL3. The 102D3 features a liftable arm type axle configuration, whereas, the 102DL3 has a self-steering axle with a pivoting truss design.

The suspension system is entirely automatic in operation and is designed to maintain a constant vehicle height regardless of load. The height control valves maintain a constant pressure in and uniform loading of the air springs regardless of the load. A pressure protection valve is incorporated into the suspension system to prevent over-pressurizing the air springs. The trailing axle air springs also feature an independent manually operated control valve. Refer to Section 4 “Air System” for more information on the pressure protection and control valves.

COMPONENTS

The suspension system consists of the following components: suspension supports and trusses, radius rods, shock absorbers, air springs, height control valves and trailing axle control valves and cylinders.

The front and rear suspension supports are bolted to their respective axle assemblies, and provide the lower mounting location for the air springs, while the chassis structure provides the upper air spring mounting. Additionally, these supports provide mountings for radius rods and shock absorbers.

The 102DL3 model coaches feature a pivoting truss assembly that allows for positive/negative castering of the trailing axle assembly. The truss assembly incorporates air operated latching and locking mechanisms along with air springs and shock absorbers.

The 102D3 model coach trailing axle assembly design is the more conventional style pivoting arm. The axle arm’s air spring support pad and shock absorber are located to allow lifting of the axle assembly by a separate suspension unloading air spring installation.

Radius rods are used to hold all axles, (except for 102D3 trailing axle), in their proper transverse and longitudinal positions. Four radius rods are used on the rear axles, four on the 102DL3’s trailing axle and five on the front axles. These rods transmit both braking and driving forces from the axles to the coach chassis.

Double-acting shock absorbers are used to dampen severe suspension movements and enhance ride characteristics. Two shock absorbers are normally used on the front axle suspension, with an additional two more for the optional heavy front axle design, four at the rear, and two on the trailing axle’s suspension.

The air springs are made from a special compound rubber molded to the proper contour and dimensions. The entire vertical load of the coach is supported by these air springs (Figure 1). The air springs are bolted to all axle and chassis supports. All suspension air springs are rolling lobe. Unloading air spring for the 102D3 trailing axle arms are double-convolute.

Delay-type height control valves increase or decrease the air pressure as required. Two height control valves are located at the rear axle, and one at the front axle. The valves are mounted on the coach body and are connected to the axles by rubber-bushed links.

⚠ WARNING ⚠

Avoid accessing suspension components from outside coach wheel well areas. Unintentional Actuation of the height control valves with fully inflated air springs could result in serious injury. Always block the coach body adequately during any inspections and/or repairs in these areas.

Because of the delay mechanism in each height control valve, the valves respond only to sustained variations in the height of the axles in relationship to the coach body. Thus no change in air pressure takes place during normal driving. However, the valves automatically regulate air pressure to compensate for changes in the load carried by the coach, or due to changes in the location of the coach load.

The 102DL3 model trailing axle air control valves regulate the functions of latching or locking mechanisms automatically, while other valves manually control air spring unloading or filling. The 102D3 model trailing axle control valves regulate the unloading/lifting systems.

The air operated cylinders actuate the latching and locking mechanisms of the 102DL3 model coach.

MAINTENANCE

Routine maintenance of the suspension system should include visual inspection for any defects in the components, and occasional test procedures to determine that the correct coach ride height is being maintained. The suspension air filter should be replaced periodically, see Section 11 “Filter Maintenance”.

The main air system provides air for the coach suspension. Refer to Section 4 for maintenance procedures for air system components. To remove axle assemblies refer to Sections 1 or 2.

1. TRAILING AXLE AIR SPRING DUMP VALVE
2. TRAILING AXLE LOW AIR PRESSURE SWITCH
3. PING TANK DRAIN VALVE
4. SYSTEM FILL VALVE
5. PING TANK
6. GOVERNOR
7. AIR COMPRESSOR
8. TRAILING AXLE REAR
9. DRIVE AXLE AIR SPRING
10. RH REAR LEVEL VALVES
11. LH REAR LEVEL VALVE
12. SUSPENSION/ACCESSORY JUNCTION BLOCK
13. PARK RESERVOIR
14. MAIN AIR CHECK VALVE
15. PRESSURE PROTECTION VALVE
16. TYPE "E" FILTER
17. WET RESERVOIR
18. LH FRONT AXLE AIR SPRING
19. RH FRONT AXLE AIR SPRING
20. FRONT AXLE LEVEL VALVE
21. AD9 AIR DRYER
22. FRONT ACCESSORY JUNCTION BLOCK
23. ACCESSORY RESERVOIR

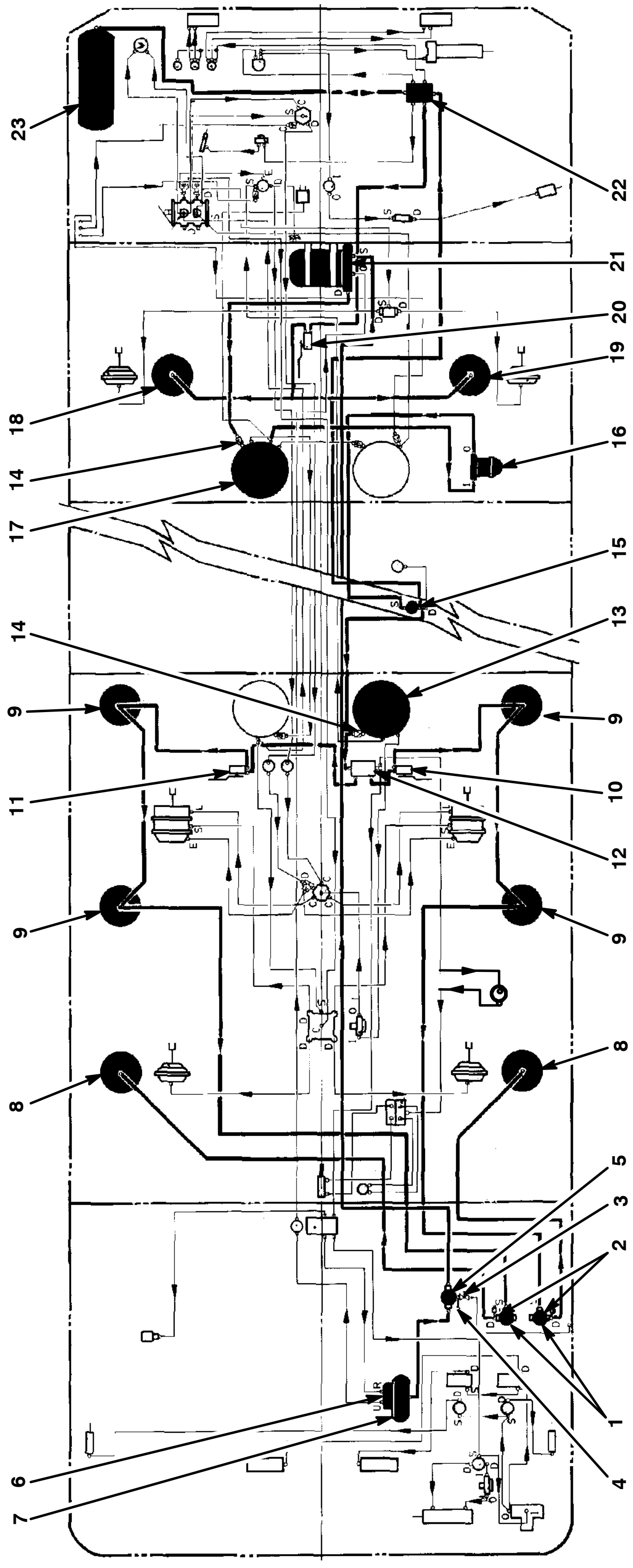


Figure 1. Suspension System

SECTION 12B

FRONT AXLE SUSPENSION

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 12B-1
Components 12B-1
Maintenance 12B-1
Torque Specifications 12B-6
Specifications 12B-7
Service Tools 12B-7

GENERAL DESCRIPTION

The D series front axle suspension system is typical with any basic or optional steering axle configurations. Furthermore, the basic suspension system can be alternately equipped for heavy duty service operations.

COMPONENTS

The typical front suspension system (Figure 1) is composed of the following: Left and right suspension support, with the latter having provisions for attachment of the transverse radius rod. One set each of upper and lower radius rods and one transverse rod, along with the anti-sway bar, stabilize the front axle assembly. The basic front suspension mounts two heavy-duty double acting shock absorbers. Two rolling-lobe type air springs support the front chassis, with one height control valve governing air spring pressure.

NOTE: Some 102DL3 model coaches were fitted with rolling-lobe type air springs of a two piece design. The procedure for removal of this type air spring is different, see “Air Spring Removal (Two Piece Design)” later in this section.

MAINTENANCE

This section will address the specific maintenance requirements of the front suspension system and its components. No specific periodic maintenance needs are required for the front suspension system, therefore, only procedures for disassembly and removal of serviceable components will be discussed.

All serviceable suspension components are mechanically fastened to the coach chassis and axle assembly. Periodic inspections of these fasteners, with special attention to their specific torque, should be undertaken.

⚠ WARNING ⚠

Avoid accessing suspension components from outside coach wheel well areas. UnIntentional Actuation of the height control valves with fully inflated air springs could result in serious injury. Always block the coach body adequately during any inspections and/or repairs in these areas.

RADIUS RODS

The radius rods maintain the correct axle location. The upper and lower radius rods maintain the axle longitudinally. The upper radius rods also act to limit vehicle roll while turning and are subject to higher loads. The single transverse radius rod maintains the axle both longitudinally and laterally.

The following instructions apply to radius rods used at the front axle. Radius rods are mounted at both ends through rod eye bushing. These bushings are made of rubber and have a steel inner and outer sleeve. New bushings should be used when rods are replaced.

Inspection

MCI recommends checking radius rod bushings at 50,000 mile (80,450 km) intervals to determine if the bushings require replacing due to wear. The Magnaflux process is recommended for detecting cracks in radius rods.

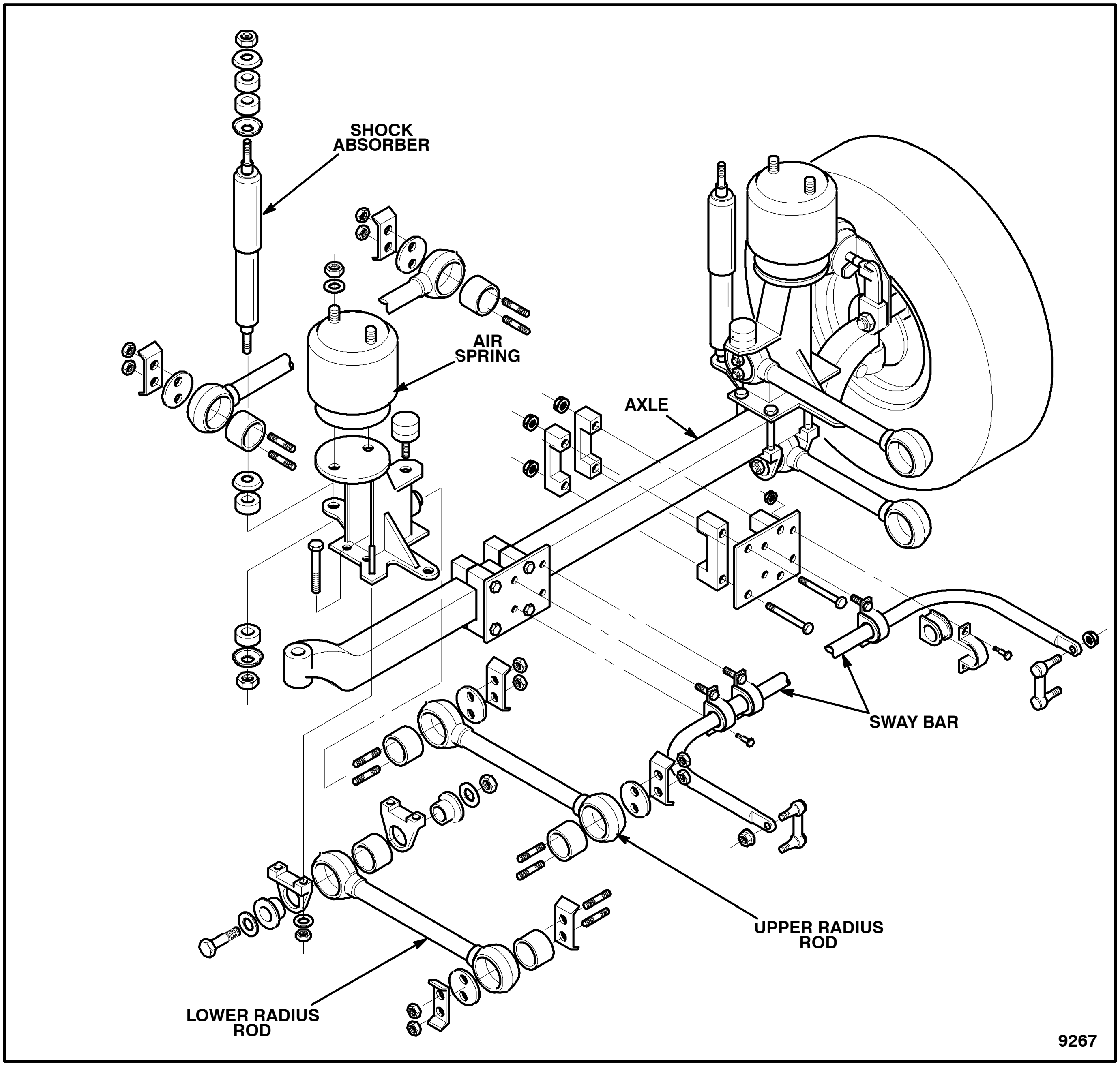


Figure 1. Front Suspension

NOTE: Do not rely on visual inspection for determining the serviceability of radius rods or their bushings.

To check the bushings for wear, place the coach over a pit, grab each rod in both hands and check for free play. If a movement of 1/32 inch or more can be detected, the bushings need to be replaced.

NOTE: If worn bushings are not replaced, excessive wear to other suspension components and tires will result.

Radius Rod Removal

Follow the procedure's steps in order.

1. Elevate and block the coach body. Elevate and block the front axle at the correct ride height.

2. Flatten locking plate tabs and unfasten nuts. Remove capscrew and nut holding the retaining bushings in place (lower rear rods).

3. Remove radius rod end plates from anchor pins. Remove the four (4) retaining half bushings (lower rear rods).

4. Remove radius rod from mounting pins or brackets.

Bushing Removal

Radius rod bushing removal and installation tools are shown on the “Service Tools” page of this sub-section.

All bushings for the transverse, upper and lower radius rods use removal tool number 20-321 and installation tool number 20-322. Additionally, a 3 inch long piece of 4 inch nominal size (schedule 80) pipe will be needed as a press spacer.

> **NOTE:** Above mentioned tools are to be used in conjunction with a hydraulic press in the removal and installation procedures that follow.

⚠ CAUTION ⚠

Support or block components as needed in accordance with good hydraulic press operating procedures.

1. Place radius rod eye and bushing on top of pipe spacer in press (Figure 2).
2. Place the removal tool on top of radius rod eye.
3. Apply pressure with the press until the bushing drops out of the eye and into the pipe. The tool will drop out also.
4. Remove the radius rod, bushing and pipe from the press.

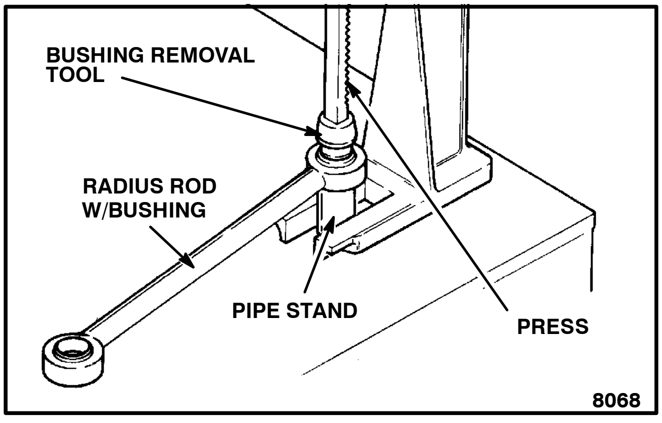

BUSHING REMOVAL TOOL
RADIUS ROD W/BUSHING
PIPE STAND
PRESS
8068

Figure 2. Removing Radius Rod Bushing

Bushing Installation

1. Coat exterior sleeve of new bushing with *Never-Seize* or equivalent anti-seize compound.

> **NOTE:** Anti-seize compounds are applied only to the bushing’s inner and outer metal sleeves.

2. Place pipe, radius rod, bushing and appropriate installation tool in press (Figure 3).
3. Apply pressure to top of tool until bushing is centered inside the radius rod eye.
4. Remove tool, radius rod and pipe from press.

Radius Rod Installation

> **NOTE:** Improper ride height will pre-load rubber bushings and shorten service life.

1. Set coach at the correct ride height (Figure 4).
2. Apply a thin coating of anti-seize to interior sleeve of newly installed bushing.

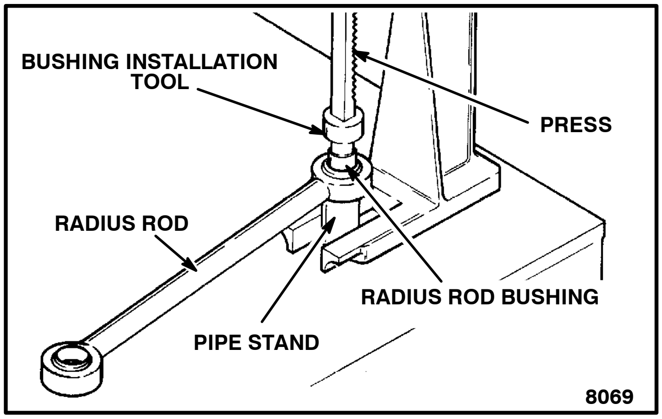

BUSHING INSTALLATION TOOL
PRESS
RADIUS ROD
RADIUS ROD BUSHING
PIPE STAND
8069

Figure 3. Installing Radius Rod Bushing

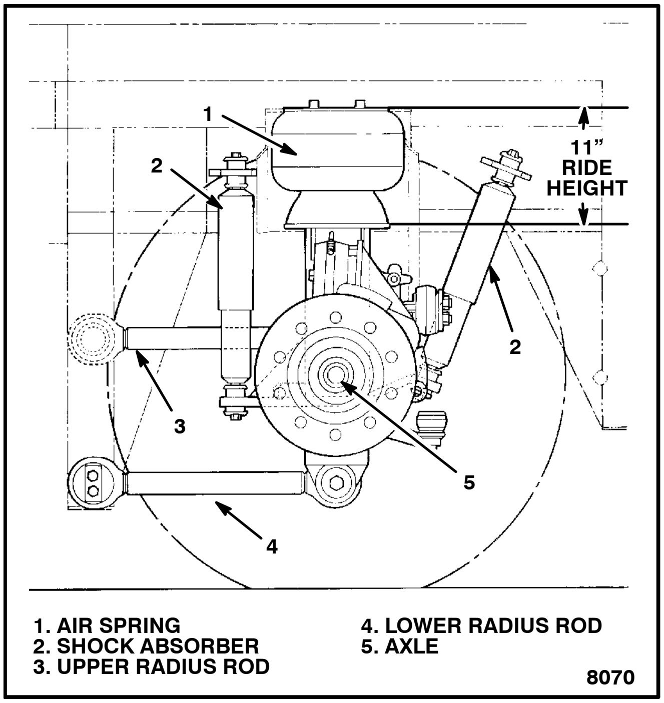

1
2
11” RIDE HEIGHT
2
3
5
4
1. AIR SPRING
2. SHOCK ABSORBER
3. UPPER RADIUS ROD
4. LOWER RADIUS ROD
5. AXLE
8070

Figure 4. Front Ride Height

CAUTION

When reinstalling radius rods, make sure that the rod is centered on the bushing before tightening retaining nuts. The radius rod should be held in a centered position with a pry bar against the coach body or axle while the stud nuts are tightened.

3. Place radius rod on mounting pins, or in bracket (lower rear rods).

4. Install end plate onto anchor pins, or retaining bushing (lower rear rods).

5. Replace the studs (if removed), washers, lockstraps and nuts.

6. Torque mounting nuts to 150-165 ft-lbs (203.4-223.7 N·m).

7. Rebend lockstraps tabs.

SHOCK ABSORBERS

The main function of the shock absorber is to regulate the vehicle axle travel by dampening the rebound motion. Fluid contained within the shock absorber is forced through a restricted opening by a piston when the suspension air springs are flexed.

The shock absorbers are heavy-duty double-acting type. They are of welded construction and cannot be repaired. Defective shock absorbers must be replaced with new units.

Shock Removal

1. Unfasten and remove hex nut, retaining washers and rubber bushings from both ends of the shock.

2. Collapse shock and withdraw from the upper mount, then lift stud end out of mounting hole in the suspension support.

Shock Installation

CAUTION

New rubber mounting bushings should be used when shock absorbers are replaced. Improper bushing pre-load may result from reuse of old bushings.

1. Wire shock in collapsed position for installation.

NOTE: Place inner/upper retaining washers over bushings before installing shocks.

2. Install upper stud end into its mount, and position lower stud end over mounting hole and cut retaining wire.

3. Install outer/lower retaining washer and hex nut and torque to attain proper bushing pre-load (Figure 5).

AIR SPRINGS

The front axle suspension's air springs should be inspected at regular intervals for any wear marks or cracks.

Two different removal procedures are provided for 102DL3 model coaches, depending on the design of the front suspension air spring assembly used. The two piece air spring (break-away) design consists of a lower spring assembly and an upper bellows retainer. The one piece air spring design incorporates an upper retainer crimped to the bellows.

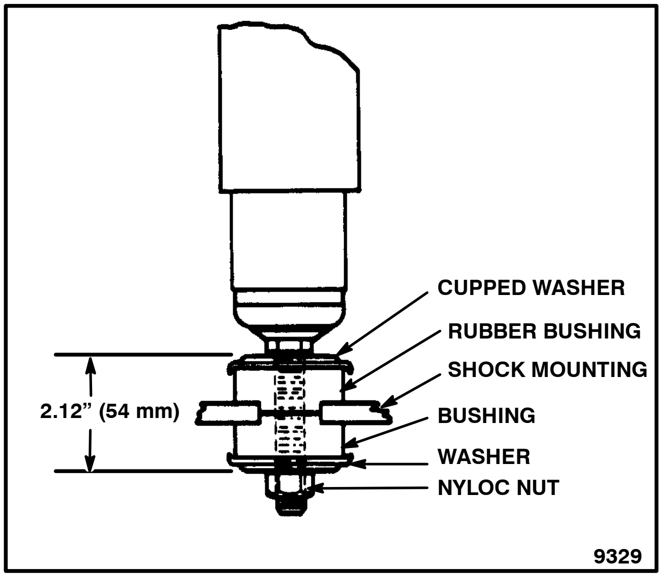


Figure 5. Shock Installation

The two piece (break-away) designs are typically reccognized as having two mounting studs and one air supply tap on the top retainer, whereas the single piece designs have one mount stud and one pipe (air supply tap) mount.

Air Spring Removal (Two Piece)

1. Turn Battery switch to "Off".

2. Block front axle at the correct ride height.

3. Remove the rear axle wheels.

4. Release air from the front suspension's air springs via the leveling valve.

5. Disconnect the air spring's lower retainer from suspension support mounting plate.

6. Flex bellows and break-away from top retainer, and remove air spring.

Air Spring Installation (Two Piece)

1. Install air spring assembly in reverse order of the removal procedure.

NOTE: Make sure that bellows top bead is secured in retainer's lip.

Air Spring Removal (Single Piece)

1. Follow steps 1 thru 5 of previous removal procedure.
2. Disconnect and remove air supply line, fitting and hex nut (stud side) from top retainer.
3. Collapse air spring bellows and remove.

Air Spring Installation (Single Piece)

1. Install air spring assembly in reverse order of the removal procedure.

ANTI-SWAY BAR

The rear anti-sway bar connects the suspension support assembly to the coach rear bogie legs. MCI recommends periodic inspection of the sway bar bushings and links at 50,000 mile (80,450 km) intervals.

NOTE: Effective with unit #45959 a new sway bar is used. The sway bar incorporates new link assemblies, cushions and stop collar type cushion clamps (Figure 6).

Removal

1. Turn battery disconnect switch to "OFF".
2. Block rear axle at the correct ride height, and remove rear wheels.
3. Unfasten and remove the flanged hex nuts securing the sway bar links to support and bar. Tap the ends of link from their mounting holes.
4. Unfasten and remove the stop collar or strap type clamps from either side of cushion mounts.
5. Unfasten and remove the cushion clamps from bogie leg crossmember and remove sway bar.

Installation

1. Reinstall sway bar in reverse order of "Removal" procedure. Torquing flanged nuts to 165-170 ft-lbs (224-230 N·m), back off and retorque to 95-100 ft-lbs (129-136 N·m).

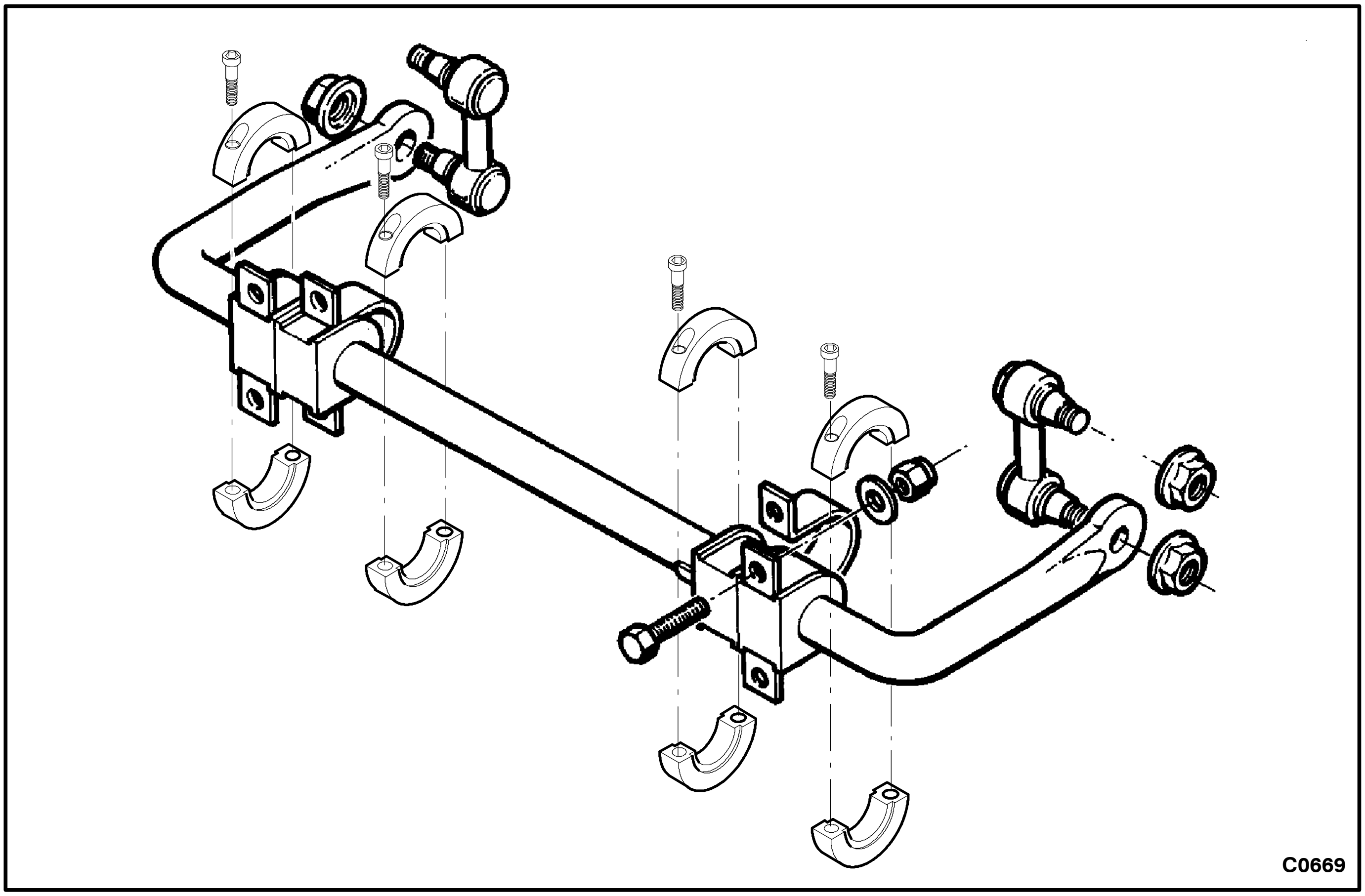


Figure 6. Sway Bar Assembly

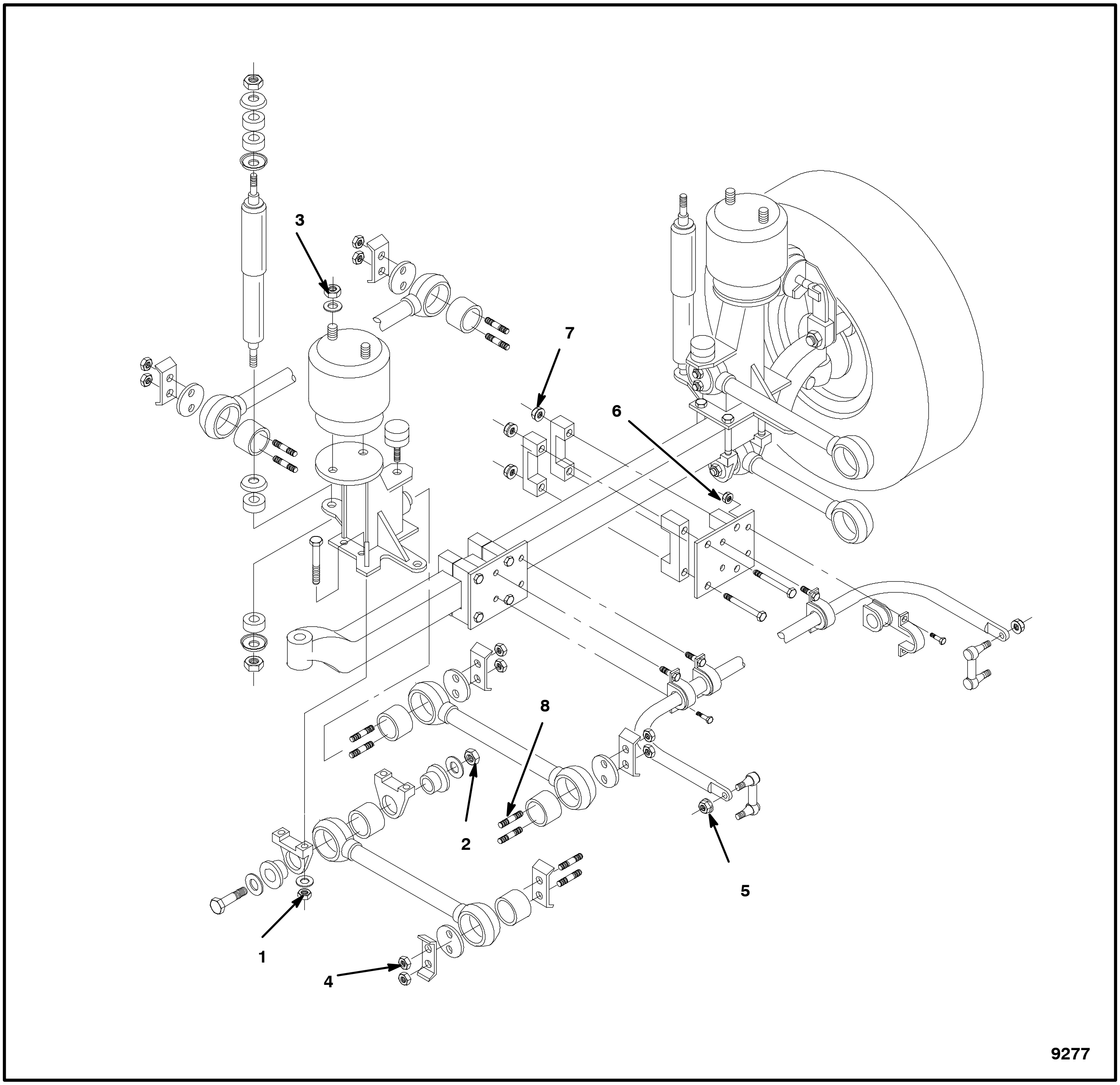


Figure 7. Torque Chart

TORQUE SPECIFICATIONS

1.	Suspension Supports To Axle Mounting Hex Nuts (Rod Retainer)	175-200 ft-lbs (237-271 N·m)
2.	Radius Rod Retainer Hex Nuts (Lower Rear)	350-390 ft-lbs (474-528 N·m)
3.	Air Spring Mounting Hex Nuts	55-65 ft-lbs (74-88 N·m)
4.	Radius Rod Mounting Stud Hex Nuts (Upper & Lower)	150-165 ft-lbs (203-223 N·m)
5.	Stabilizer Link Hex Nuts	95-100 ft-lbs (128-135 N·m)
6.	Stabilizer Bar Retainer Clamp Hex Nuts	65-70 ft-lbs (88-94 N·m)
7.	Stabilizer Bar Support To Axle Mounting Hex Nuts	160-190 ft-lbs (216-257 N·m)
8.	Radius Rod Mounting Pin Studs	60-65 ft-lbs (81-88 N·m)

SPECIFICATIONS

SUSPENSION AIR SPRING

Manufacturer	Goodyear, Firestone
Part Number	(Two Piece Design) 12L-1-104
Part Number	(Single Piece Design) 12L-1-140
Type	Rolling Lobe
Size	12.8 inches (325 mm)

SHOCK ABSORBER

Manufacturer	Delco, Gabriel
Part Number	12L-5-58
Collapsed Length	14.87 inches (377 mm)
Extended Length	24.40 inches (619 mm)

RADIUS RODS

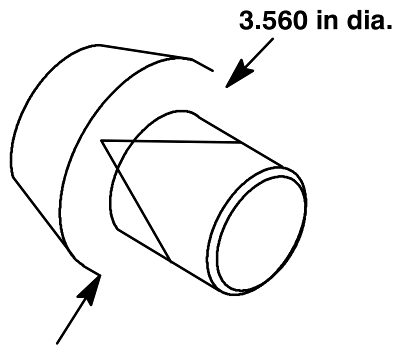
Manufacturer	Clevite
Part Number	(Upper & Lower) 12L-5-61
Part Number	(Transverse) 12L-5-62

SWAY BAR ASSEMBLY

Make	Hellwig
Part Number (Effective with Unit #45959)	12L-5-83

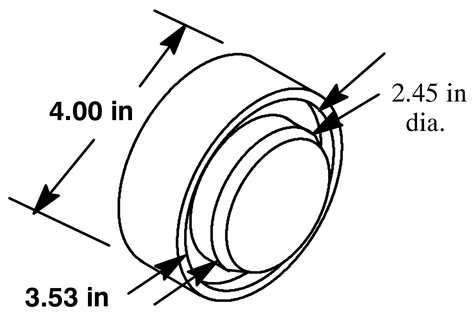
SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.



20--321

Removal Tool for Radius Rod Bushing 12J–1–133



20–322

Installation Tool for Radius Rod Bushing 12J–1–133

9288

SECTION 12C

DRIVE AXLE SUSPENSION

CONTENTS OF THIS SECTION

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General Description 12C-1
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Maintenance 12C-1
Torque Specifications 12C-7
Specifications 12C-8
Service Tools 12C-9

GENERAL DESCRIPTION

The D series rear axle suspension system is typical with basic or optional drive axle configurations. There are some minor differences in the attachment of the radius rods between the specific models, but otherwise, the installations are similar. The 102DL3's radius rods attach to the front of the chassis, whereas the 102D3's radius rods attach at the rear.

COMPONENTS

The typical rear suspension systems (Figure 1 2) are composed of the following: Left and right suspension supports assemblies, with the supports for the 102D3 having provisions for attaching the shock absorber's upper mount point on the horizontal only. One set each of upper (diagonally mounted) and lower (longitudinally mounted) radius rods stabilize the rear axle assembly. Four heavy duty shock absorbers, along with four rolling-lobe type air springs, (of one piece design), support the rear suspension. Two left and right height control valves maintain pressure in the rear axle air springs.

NOTE: Some 102DL3 model coaches were fitted with rolling-lobe type air springs of a two piece design. The procedure for removal of this type air spring is different, see "Air Spring Removal (Two Piece Design)" later in this section.

MAINTENANCE

This section will address the specific maintenance requirements of the rear suspension system and its components. There are no specific periodic maintenance needs for the rear suspension system, therefore, only procedures for disassembly and removal of serviceable components will be discussed.

All serviceable suspension components are mechanically fastened to the coach chassis and axle assembly. A periodic inspection of these fasteners, with special attention to their specific torque, should be undertaken.

⚠ WARNING ⚠

Avoid accessing suspension components from outside coach wheel well areas. Unintentional Actuation of the height control valves with fully inflated air springs could result in serious injury. Always block the coach body adequately during any inspections and/or repairs in these areas.

RADIUS RODS

The lower radius rods maintain the axle longitudinally. The two upper radius rods are offset, forming a wishbone, and maintain the axle both longitudinally and laterally. The upper radius rods also act to limit vehicle roll while turning and are subject to higher loads.

The following instructions apply to radius rods used on the rear drive axle suspension. Radius rod ends are mounted via mounting tabs on the rubberized saddle pins that act as rod bushings.

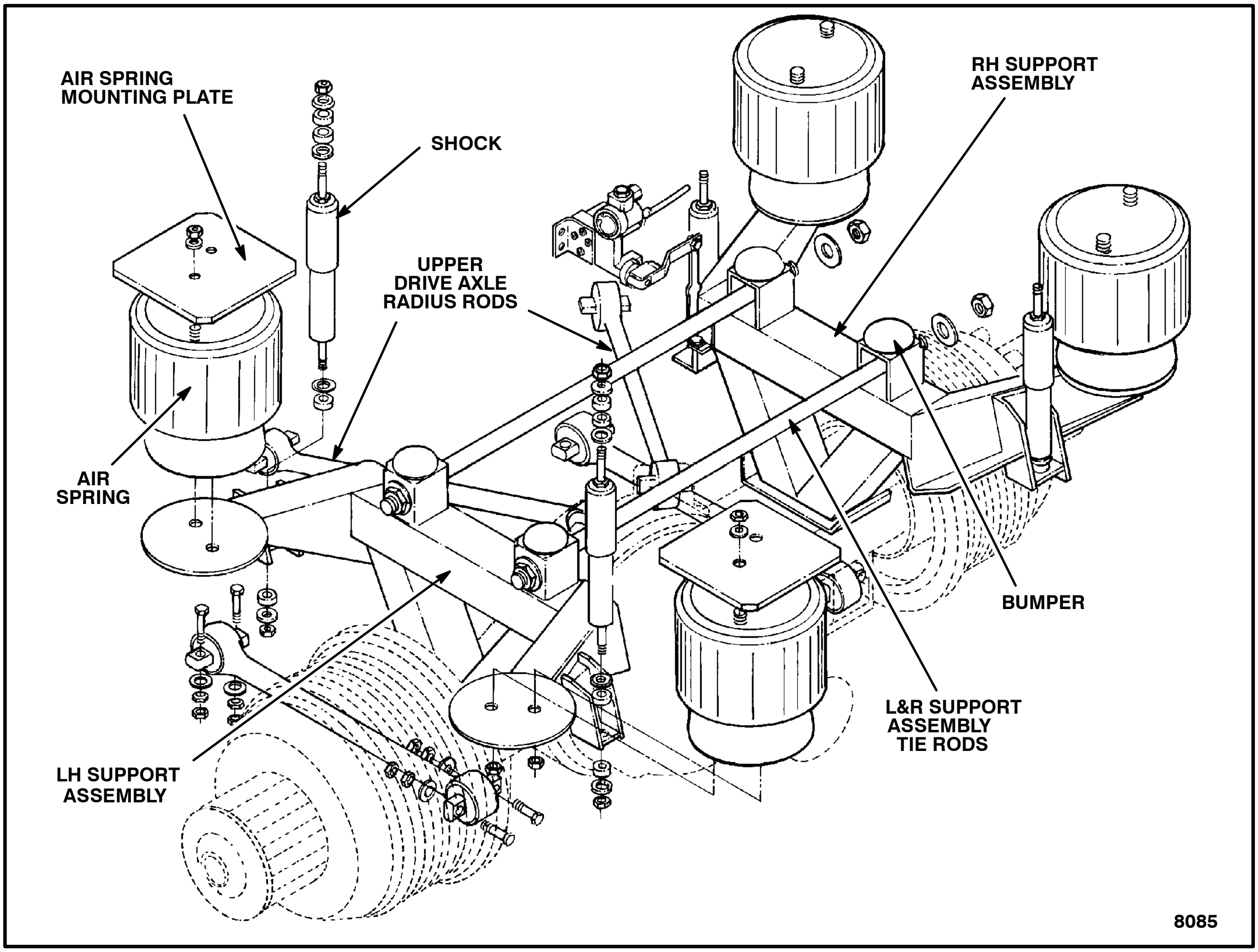

AIR SPRING MOUNTING PLATE
SHOCK
RH SUPPORT ASSEMBLY
UPPER DRIVE AXLE RADIUS RODS
AIR SPRING
BUMPER
L&R SUPPORT ASSEMBLY TIE RODS
LH SUPPORT ASSEMBLY
8085

Figure 1. Rear Suspension 102DL3

Inspection

NOTE: Do not rely on visual inspection for determining the serviceability of radius rod and their bushings.

MCI recommends checking radius rod bushings at 50,000 mile (80,450 km) intervals to determine if the bushings require replacing due to wear. The Magnaflux process is recommended for detecting cracks in the radius rods.

Due to the mounting configuration of the radius rods to the rear suspension supports and rear bogie assembly, special attention should be placed on the inspection of these rods and their saddle pin bushings.

NOTE: If worn bushings are not replaced, excessive wear to other suspension components and tires will result.

Radius Rod Removal

1. Elevate and block the coach body. Elevate and block the rear axle at the correct ride height.
2. Remove the drive axle wheels.
3. Unfasten and remove the upper radius rods from the axle's top mounting bracket shown in Figures 1 and 2.
4. Unfasten and remove the remaining radius rods.

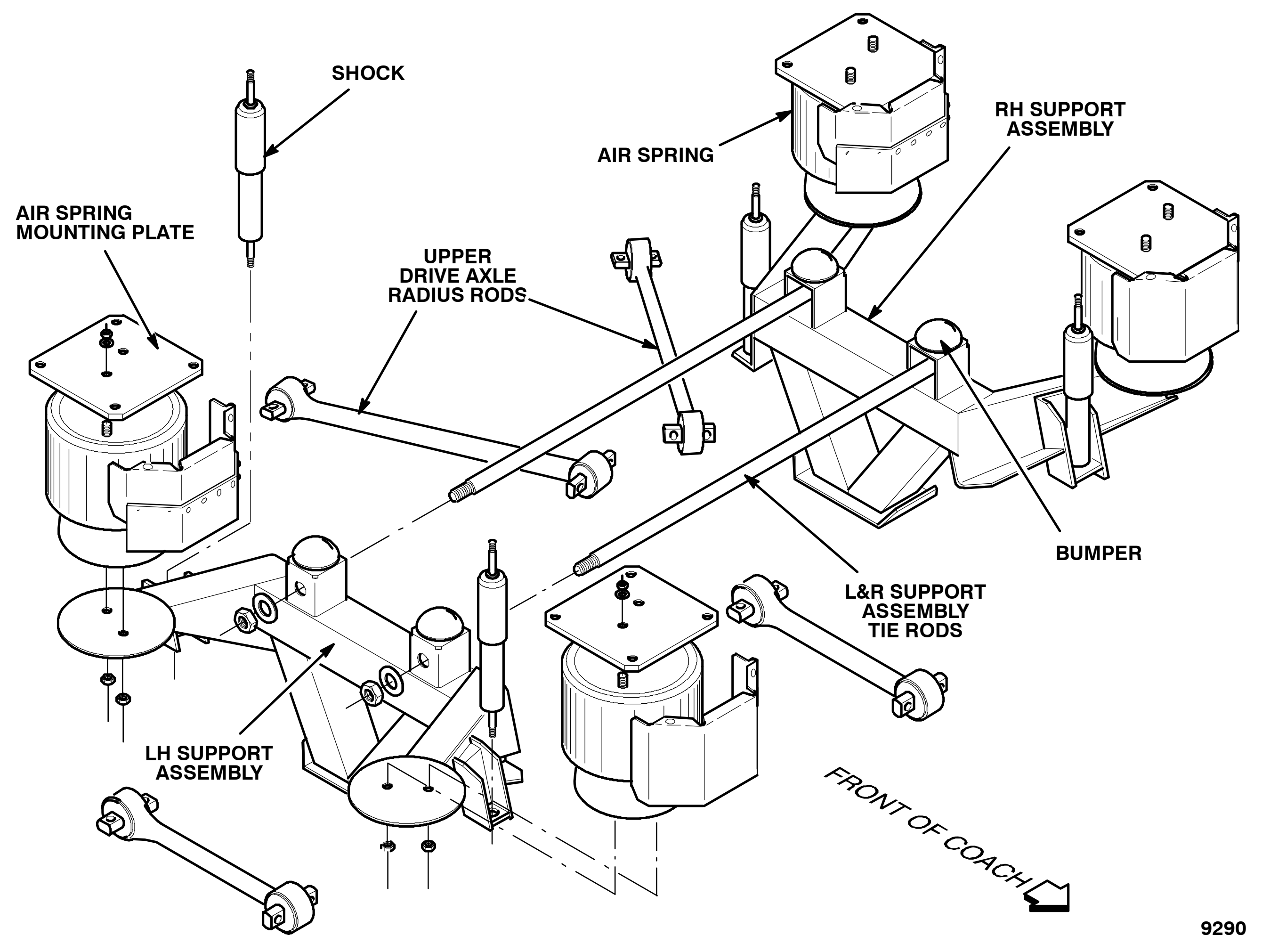

SHOCK
AIR SPRING
RH SUPPORT ASSEMBLY
AIR SPRING MOUNTING PLATE
UPPER DRIVE AXLE RADIUS RODS
BUMPER
L&R SUPPORT ASSEMBLY TIE RODS
LH SUPPORT ASSEMBLY
FRONT OF COACH
9290

Figure 2. Rear Suspension 102D3

Bushing Removal

Radius rod bushing removal and installation tools are shown on the “SERVICE TOOLS” page at the end of this sub-section.

Rear axle radius rod bushings require the use of a special sleeve installation tool 20-389. The replacement saddle pin bushings have metal outer sleeves. Additionally, a 2-inch diameter round bar, (for removing pins), and a 7-inch long piece of 3-inch nominal size (schedule 80) pipe will be needed as a press spacer.

NOTE: All tools are to be used in conjunction with a hydraulic press in the removal and installation procedures that follow.

CAUTION

Supportorblockcomponentsinaccordancewith good hydraulic press operating procedures.

1. Place radius rod eye with saddle pin bushing on top of spacer pipe in press (Figure 3).
2. Place the round bar on top of radius rod saddle pin’s mounting tab.
3. Apply pressure with the press until the bushing drops out of the eye and into the pipe. The round bar will drop out also.
4. Remove the radius rod, bushing and round rod from press.
5. Clean the remainder of the bonded rubber residue from inside diameter of the rod eye.

Bushing Installation

1. Coat exterior of new saddle pin bushing with *Never-Seize* compound or equivalent anti-seize compound.

NOTE: Anti-seize compounds are applied only to the bushing’s outer metal sleeve.

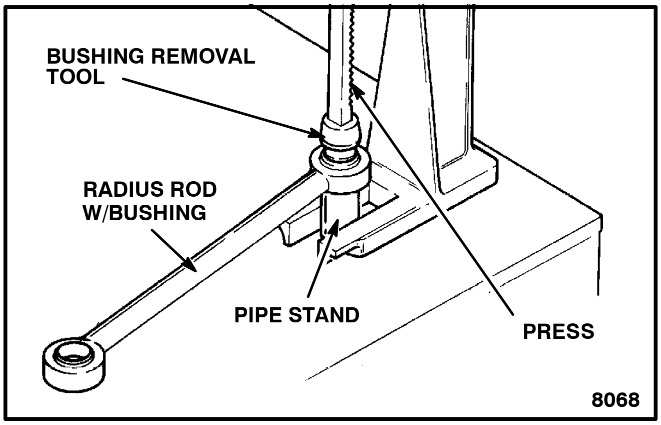


Figure 3. Bushing Removal

2. Place radius rod, bushing and appropriate sleeve installation tool in press, centered on top of spacer pipe (Figure 4).

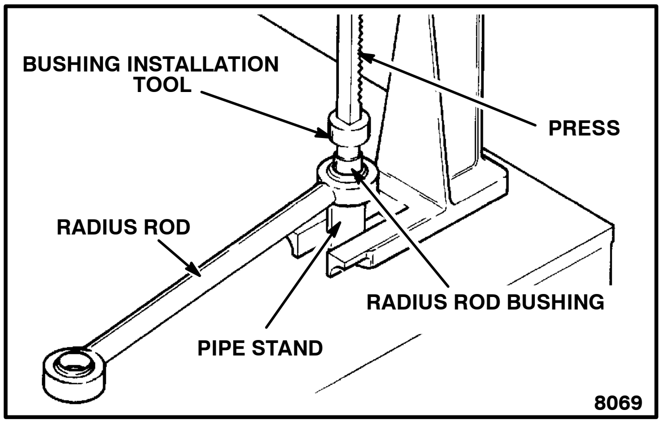


Figure 4. Bushing Installation

> **NOTE:** Correct Orientation of the saddle pin tabs in relationship to their mounting must be made before pressing pin into rod eye.

3. Apply pressure to top of tool until bushing is seated inside the radius rod eye.

> **NOTE:** Cut-outs are provided in the sleeve installation tool for determining correct seating.

4. Remove tool, radius rod and pipe from press.

Radius Rod Installation

1. Set coach at the correct ride height (Figure 5).
2. Apply a thin coating of anti-seize on all mounting surfaces of the radius rod saddle pins and reinstall.

> **NOTE:** Anti-seize is applied only to saddle pin bushing's tab-to-chassis mating points and fasteners.

3. Install fasteners with hex nuts out and torque to 220 ft-lbs (300 N·m).

SHOCK ABSORBERS

The main function of the shock absorber is to regulate the vehicle axle travel by dampening the rebound motion. Fluid contained within the shock absorber is forced through a restricted opening by a piston when the suspension air springs are flexed.

The shock absorbers are heavy-duty double-acting type. They are of welded construction and cannot be repaired. Defective shock absorbers must be replaced with new units.

Some early models 102DL3 shock absorbers have stud type mountings at both shock ends. All other models are fitted with shocks that have a stud type mount at the bottom and an eye-ring type mount at the top for horizontal attachment to bogie assembly. Follow the applicable procedures for removing shock absorbers.

Shock Removal (Stud Mount)

1. Unfasten and remove hex nut, retaining washers and rubber bushings from both ends of the shock.
2. Collapse shock and withdraw from the upper mount, then lift stud end out of mounting hole in the suspension support.

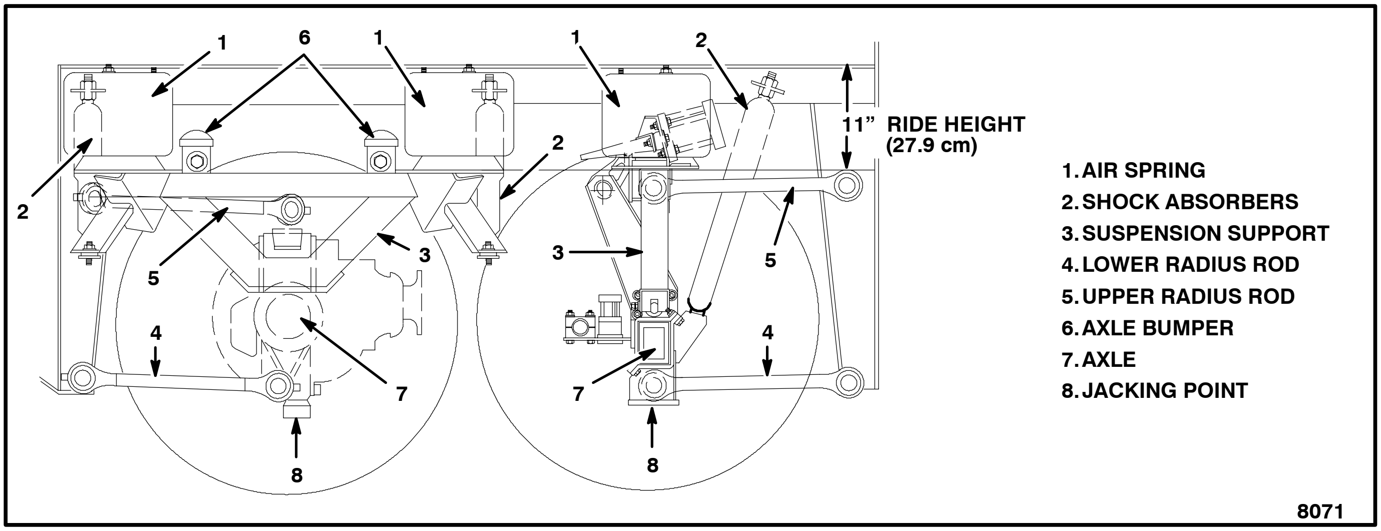

1
6
1
1
2
2
2
11” RIDE HEIGHT (27.9 cm)
5
3
3
5
4
4
7
7
8
8
1. AIR SPRING
2. SHOCK ABSORBERS
3. SUSPENSION SUPPORT
4. LOWER RADIUS ROD
5. UPPER RADIUS ROD
6. AXLE BUMPER
7. AXLE
8. JACKING POINT
8071

Figure 5. Rear Suspension

Shock Removal (Eye-ring Mount)

1. Unfasten and remove hex nut, retaining washers and slide shock and conical bushings off shock mounting stud.

2. Follow Step 1 of the previous procedure for removal of bottom shock mount, then collapse shock and remove from suspension support.

Shock Installation (Stud Mount)

CAUTION

New rubber mounting bushings should be used when shock absorbers are replaced. Improper bushing pre-load may result from reuse of old bushings

1. Wire shock in collapsed position for installation.

2. Install upper stud or eye-ring end into its mount, and position lower stud end over mounting hole and cut retaining wire.

NOTE: Place inner/upper retaining washers over bushings before installing shocks.

3. Install outer/lower retaining washer and hex nut and torque to attain proper bushing pre-load (Figure 6).

AIR SPRINGS

The rear axle suspension's air springs should be inspected at regular intervals for any wear marks or cracks.

Two different removal procedures are provided for 102DL3 model coaches, depending on the design of the rear axle suspension air spring assembly used. The two piece air spring (break-away) design consists of a lower spring assembly and an upper bellows retainer. The one piece air spring design incorporates an upper retainer crimped to the bellows.

The two piece (break-away) designs are typically reccognized as having two mounting studs and one air supply tap on the top retainer, whereas the single piece designs have one mount stud and one pipe (air supply tap) mount.

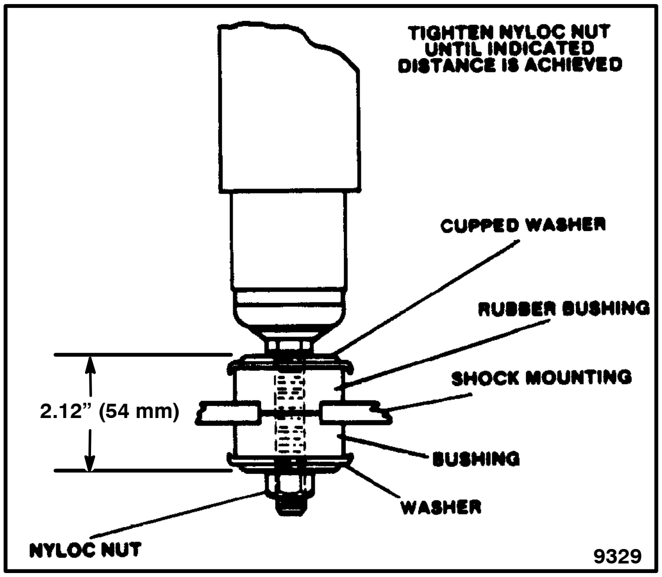

TIGHTEN NYLOC NUT UNTIL INDICATED DISTANCE IS ACHIEVED
CUPPED WASHER
RUBBER BUSHING
SHOCK MOUNTING
2.12” (54 mm)
BUSHING
WASHER
NYLOC NUT
9329

Figure 6. Shock Installation

Air Spring Removal (Two Piece)

1. Turn battery switch to “Off”.
2. Block rear axle at the correct ride height.
3. Remove the rear axle wheels.
4. Release air from the rear drive suspension's air springs via the leveling valve.

5. Disconnect the air spring's lower retainer from suspension support mounting plate.

6. Flex bellows and break-away from top retainer, and remove air spring.

NOTE: Air springs can be removed and replaced with shields in-place.

Air Spring Installation (Two Piece)

1. Install air spring assembly in reverse order of the removal procedure.

NOTE: Make sure that bellows top bead is secured in retainer's lip.

Air Spring Removal (Single Piece)

1. Follow Steps 1 thru 5 of previous removal procedure.

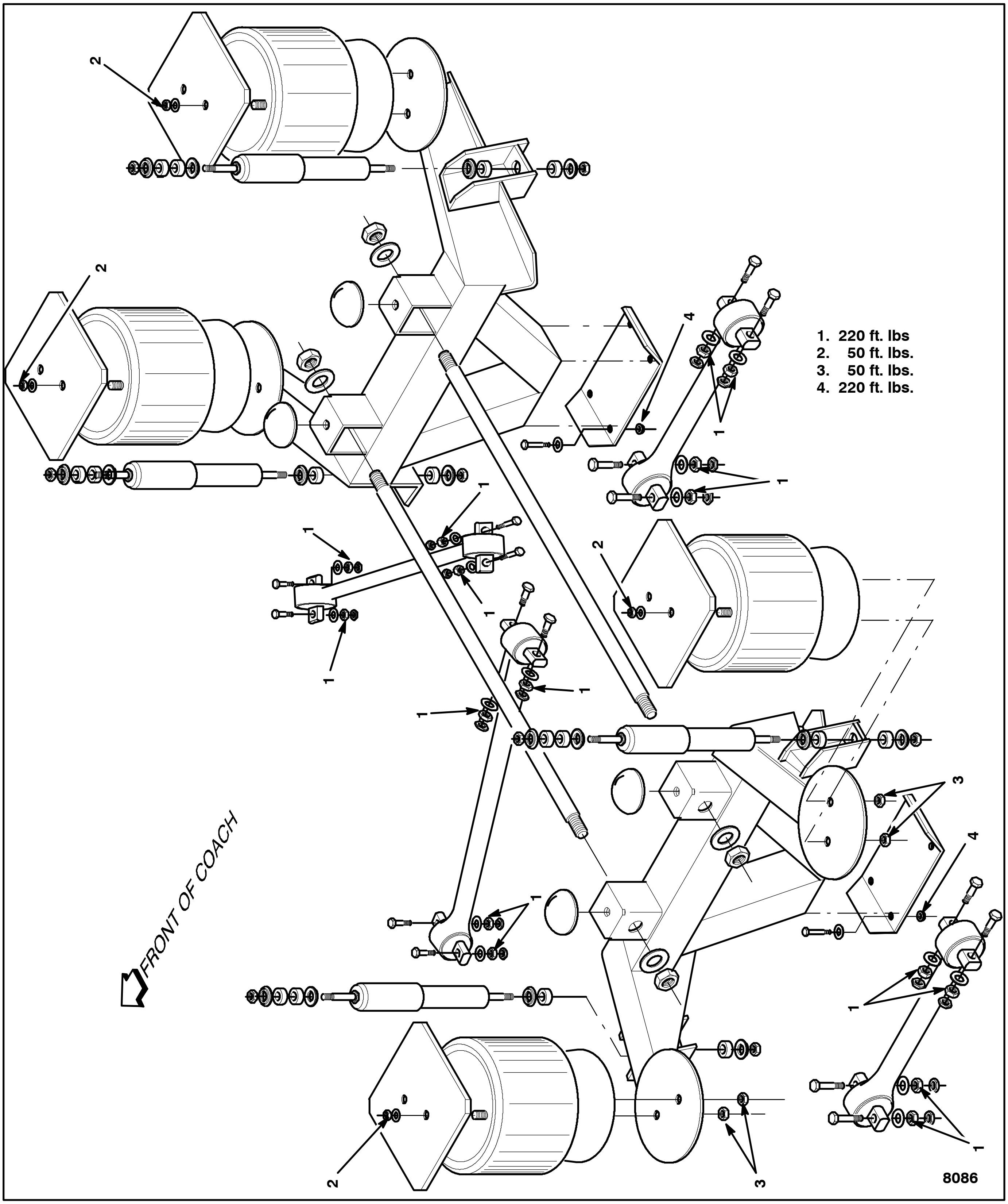
2. Disconnect and remove air supply line, fitting and hex nut (stud side) from top retainer.

3. Collapse air spring bellows and remove.

Air Spring Installation (Single Piece)

1. Install air spring assembly in reverse order of the removal procedure.

TORQUE SPECIFICATIONS



2
2
4
1
1
1
1
2
1
1
1
1
3
4
1
1
1
FRONT OF COACH
2
3
8086

1. 220 ft. lbs
2. 50 ft. lbs.
3. 50 ft. lbs.
4. 220 ft. lbs.

SPECIFICATIONS

SUSPENSION AIR SPRING

Manufacturer	Goodyear, Firestone
Part Number	(Two Piece Design 102DL3) 12L-1-104
Part Number	(Single Piece Design) 12L-1-140
Type	Rolling Lobe
Size	12.8 inches (325 mm)

SHOCK ABSORBER

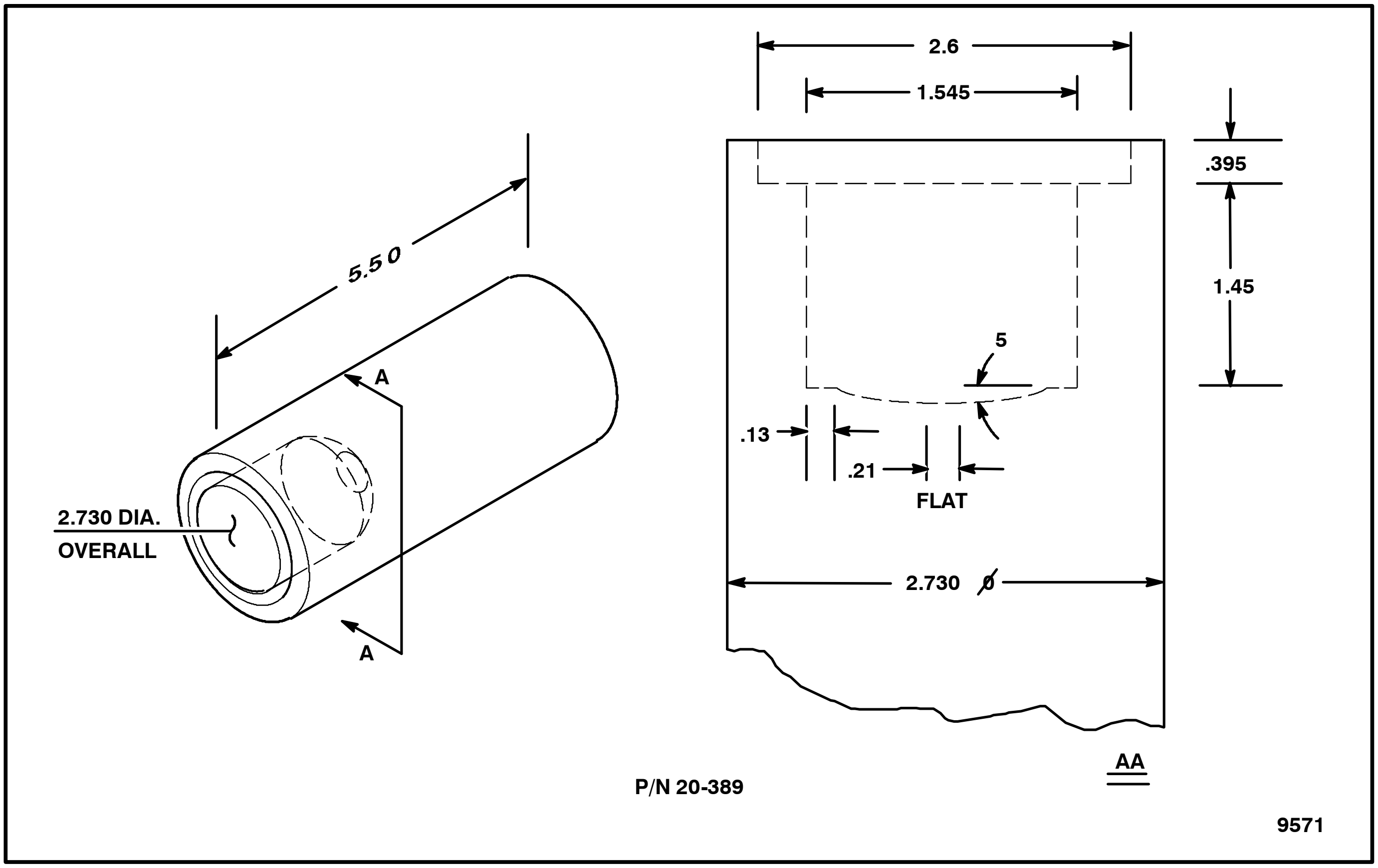
Manufacturer	Delco, Gabriel
Part Number	(Stud Type 102DL3) 12L-5-71
Part Number	(Stud & Eye-ring 102D3) 12L-5-88
Collapsed Length	(102DL3) 15.31 inches (388 mm)
Extended Length	(102DL3) 23.31 inches (592 mm)

RADIUS RODS

Manufacturer	Clevite
Part Number	(Upper 102DL3) 12L-4-135
Part Number	(Lower 102DL3) 12L-4-134
Part Number	(Upper 102D3) 12L-5-79
Part Number	(Lower 102D3) 12L-5-78

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.


5.50
A
A
2.730 DIA. OVERALL
2.6
1.545
.395
1.45
5
.13
.21
FLAT
2.730 ⌀
AA
P/N 20-389
9571

Install and Removal Tool for 12L-4-216

SECTION 12D

TRAILING AXLE SUSPENSION

CONTENTS OF THIS SECTION

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GENERAL DESCRIPTION

The D series coach models are equipped with two different trailing axle suspension systems. The suspension systems reflect the differences in axle designs that are use between the models. This sub-section will address both trailing axle suspension systems and their component parts as regards to their operation and maintenance.

The 102DL3 models are equipped with a self-steering axle with pivoting (variable caster) truss design. This design features electrically controlled air-actuated caster control mechanism. The variable caster function is automatically controlled through the coach back-up lamp circuit and locking function controlled by the speed sensor switch in the front junction box. Both functions can be monitored through tell-tale warning lamps actuated by the air cylinder's reed switches.

The 102D3 models feature a liftable swing-arm type axle configuration that works in combination with either the optional electrically controlled or the manually operated tag axle unloading systems. If specified, both of these features can be actuated (by separate switches) from the driver's dash. The lift/unload systems are protected by a low air switch and alarm circuit.

Some coaches may be equipped with the electrically operated fully retracting trailing axle feature are able to completely lift both trailing axles up and off the ground through a dash mounted switch. The system utilizes air pressure to lift and hold the axles up during service or emergency conditions.

COMPONENTS

SUSPENSION SYSTEM (102DL3)

The 102DL3's trailing axle suspension consists of a pivoting suspension truss assembly complete with latching and locking mechanism (Figure 1). One set each of upper (diagonally mounted) and lower (longitudinally mounted) radius rods stabilize the trailing axle assembly. Two heavy-duty double-acting shock absorbers, along with two rolling-lobe type air springs, (of one piece design), support the rear suspension. Additionally, a steering dampening shock absorber is installed between the tie rod and axle assemblies to control self-steering function.

NOTE: Some 102DL3 model coaches were fitted with rolling-lobe type air springs of a two piece design. The procedure for removal of this type air spring is different, see "Air Spring Removal (Two Piece Design)" later in this section.

Truss Assembly

The truss assembly consists of a support truss that is clamped to the axle by LH/RH upper and lower clamp assemblies. The truss pivots on the upper clamp's pin type bushing. The locking and latching mechanisms or mechanically fastened or welded to the truss and axle. Gross axle capacity is 12,000 lbs (5443.2 kg).

Latching Mechanism

The latching mechanism is the integral part of the self-steering feature. The latch is actuated by a heavy-duty air cylinder, which in-turn retains the bolted on arm "horn" assembly of the axle. The mechanical latch mechanism assures that braking loads are not transmitted through to the cylinder.

Locking Mechanism

A lock mechanism actuated by a small air cylinder is mounted on the axle. At highway speeds, a switch automatically triggers the cylinder, activating the mechanism for locking the tie rod for straight ahead wheel position, cancelling the self-castering feature. This restores skid control for the trailing axle during turns.

SUSPENSION SYSTEM (102D3)

The basic 102D3 unloading type trailing axle suspension (Figure 2) consists of two heavy-duty double-acting shock absorbers, along with two rolling-lobe type air springs. The unloading feature is operated through two full port air control manual dump valves. The optional electrically operated unloading system can also be incorporated with a trailing axle retracing (lifting) system.

The electrically operated retractable (liftable) trailing axle feature consists of two air spring lift actuators, two suspension air springs, two trailing axles which accept both suspension and actuator air spring assemblies, separate unloading and retracting air circuits, one five-port four-position electrically controlled solenoid operated RH valve and one three-port two-position electrically controlled solenoid operated LH valve within these circuits.

NOTE: See Section 12E for more detailed information on the control components of the suspension systems.

OPERATION

SELF-STEERING FUNCTION

Normal Operation

The 102DL3 models equipped with the self-steering trailing axle system feature several automatic functions. All of the automatically controlled functions are performed electro-mechanically through the actuation of locking or latching air cylinder circuits. The system's operation is sequential. First, auto locking and unlocking is controlled by the coach speed sensor. Secondly, actuation of the castering mechanism is controlled via transmision gear selection (i.e., back-up light circuits) for reverse travel.

When coach is in forward travel, the latch mechanism's air cylinder is in a retracted position. The mechanically fastened axle latching arm, or "Horn", is retained against the truss by the latch's tongue plate. When in reverse travel, the latch's air cylinder is extended, pushing the clevis rollers over the tongue's lift ramps, lifting the tongue plate, thereby, releasing the latching arm and allowing the axle and truss assembly to pivot forward.

⚠ CAUTION ⚠

Traveling in either direction with the self-castering control mechanism set for an opposing direction will cause the trailing axle steering to fully lock to one side, possibly damaging the suspension and/or tires.

Self-castering is achieved by rotating the axle in pitch (above the lateral axis) through the pivot block's bushings (Figures 3 and 4). This pivoting action about the spindle provides a caster from 3 degrees positive (forward motion) to 3 degrees negative (reverse travel). The latching mechanism retains the bolted on "horn" (catch) of the axle. The latch mechanism assures that braking loads are not transmitted through to the air cylinder.

NOTE: No castering (latching or unlatching) function can be performed while locking mechanism is engaged.

At speeds less than 15 mph the locking cylinder on the tie rod unlocks, freeing the axle to track in the direction of the coach travel. This is effective in both the forward and reverse direction of travel. At speeds above 35 mph the locking cylinder on the tie rod locks, and allows the axle to perform as a typical trailing axle.

The automatic self-steering feature is equipped with two tell-tale warning lights and a buzzer to warn driver in the event of system malfunction. Additionally, the system incorporates a manually operated override "Tag Lock" switch.

Under normal operating conditions, the two warning lights and the buzzer will occasionally activate for brief periods. When the speed of the coach crosses the 20 mph point, both the "tag lock" light and the buzzer will activate for a fraction of a second. Similarly, when shifting from forward to reverse or vice-versa, both the "tag steering" light and the buzzer will activate for a fraction of a second. These conditions are normal, it is only when they remain "ON" that there is a problem.

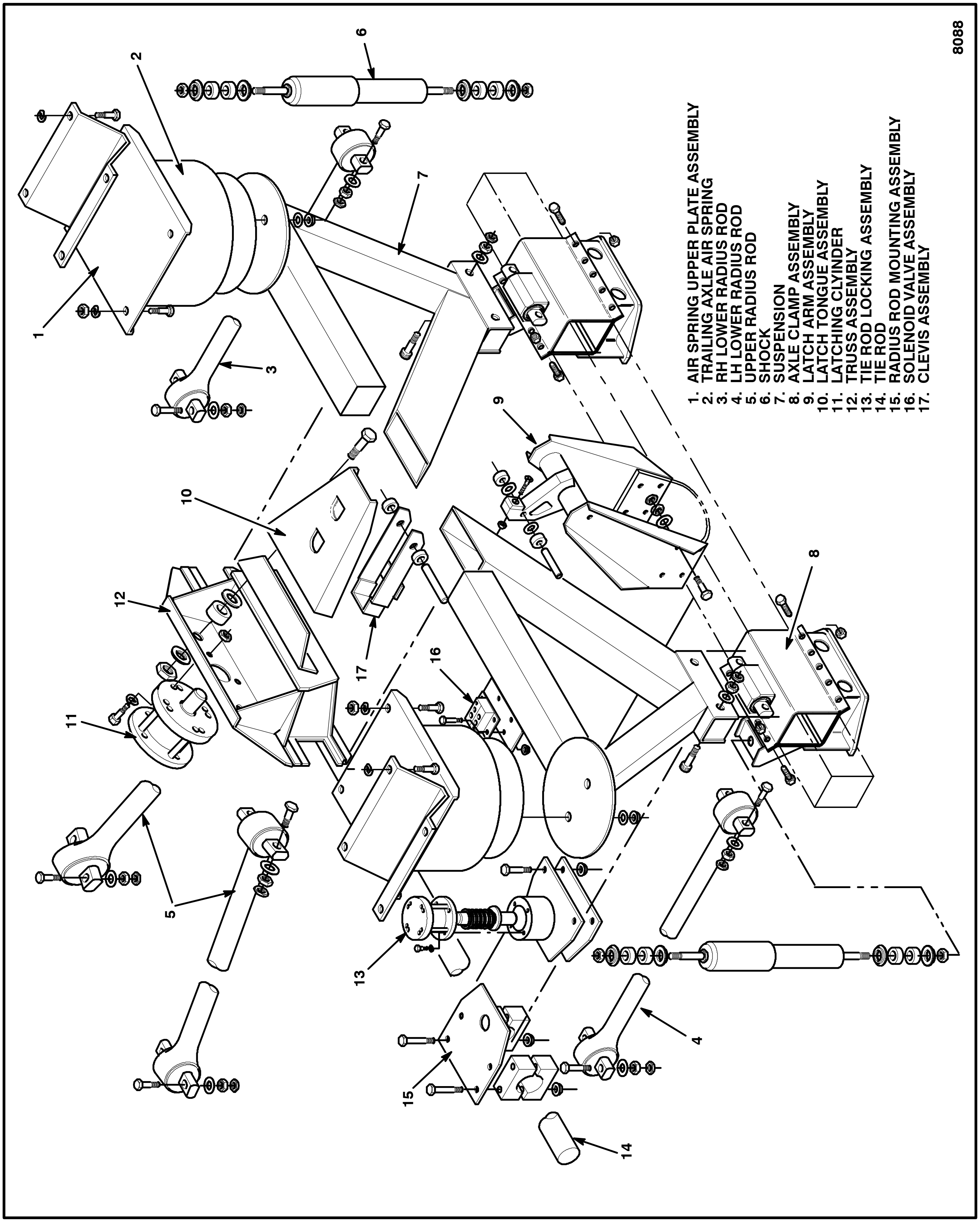
1. AIR SPRING UPPER PLATE ASSEMBLY
2. TRAILING AXLE AIR SPRING
3. RH LOWER RADIUS ROD
4. LH LOWER RADIUS ROD
5. UPPER RADIUS ROD
6. SHOCK
7. SUSPENSION
8. AXLE CLAMP ASSEMBLY
9. LATCH ARM ASSEMBLY
10. LATCH TONGUE ASSEMBLY
11. LATCHING CLYINDER
12. TRUSS ASSEMBLY
13. TIE ROD LOCKING ASSEMBLY
14. TIE ROD
15. RADIUS ROD MOUNTING ASSEMBLY
16. SOLENOID VALVE ASSEMBLY
17. CLEVIS ASSEMBLY
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Figure 1. Trailing Suspension (102DL3)

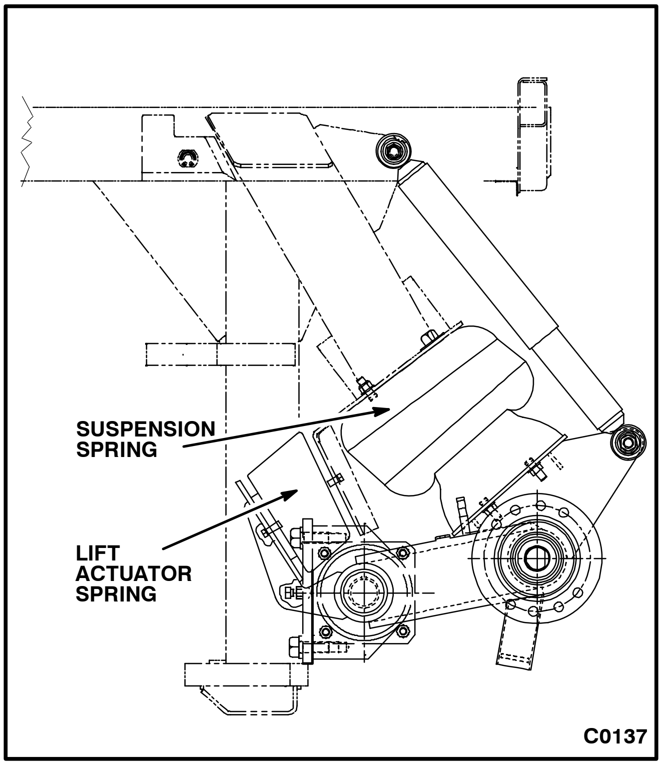

Figure 2. Trailing Suspension (102D3)

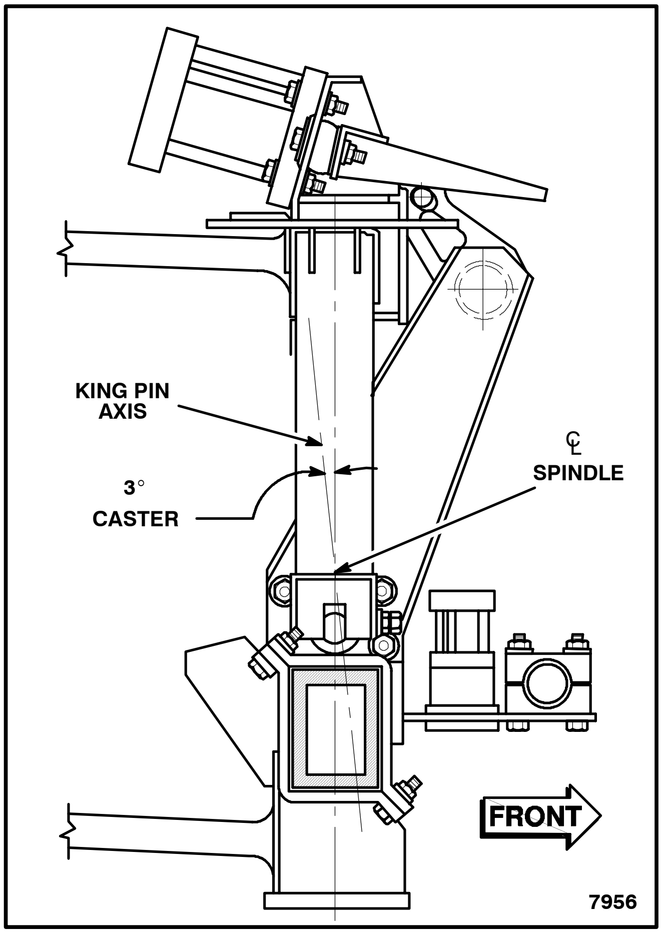

Figure 3. Trailing Axle - Forward

Fault Operation

Two warning lights are located in the left-hand telltale and are identified as “TAG STEERING” and “TAG LOCKED”. Tell-tale lights, when lit, indicate a system fault or malfunction. A “TAG STEERING” fault will also sound a buzzer alarm.

For example, if the tell-tale light for “TAG STEERING” comes on and stays illuminated, it would indicate that the trailing axle is set in the wrong position for the current direction of travel selected.

⚠ CAUTION ⚠

If the trailing axle’s caster control mechanism fails to position the axle properly, travel should be suspended immediately. Driving with trailing axle improperly positioned may cause trailing axle suspension and/or tire damage.

The coach may resume travel after the axle has been locked in a straight ahead position. This is done by actuating the “TAG LOCKED” switch and either driving the wheels straight or manually straightening them.

If the “TAG LOCKED” warning lamp illuminate and remains on, it would indicate either the axle is unlocked above 20 mph or that the axle is locked below 15 mph.

NOTE: Some amount of forward or reverse travel may be required to set the caster and turn off the tell-tale warning after a directional change has been made.

The manual override switch is located on the lower left-hand switch panel and labelled “TAG LOCK”. This switch manually locks the trailing axle and de-activates the buzzer, yet leaves the warning lights “ON”. This indicates to others that a problem exists with the trailing axle, and also that the axle is “LOCKED” in the forward position and is still driveable.

UNLOADING FUNCTION

The unload function is accomplished by positioning the manual axle unloading valves to the exhaust (horizontal) position. When the valve is positioned in this manner air supply from the drive axle bellow is blocked, and suspension bellows slowly exhaust through the dump valves. The electrically operated version exhausts the bellows through two solenoid valves located between the manual valves and supply from drive axle bellows. Bellows fill pressure is regulated via the leveling valves.

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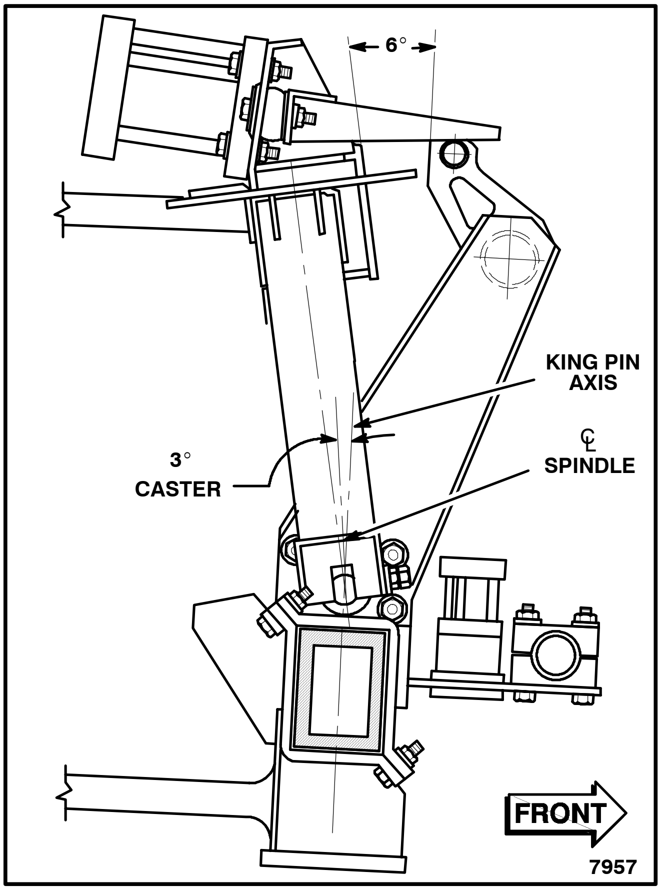


Figure 4. Trailing Axle Reverse

RETRACTING FUNCTION

The lift function is accomplished by positioning the lift/load switch located on the LH switch panel to the "Up" position. When the switch is positioned in this manner a circuit is completed to the solenoid valve. Air begins to slowly exhaust from the trailing axle suspension bellows, and simultaneously, a greater volume of air is applied to the lift actuator assemblies.

NOTE: Filling of the trailing axle's suspension air springs after completion of the lift or unload function is accomplished, via the rear axle suspension's normal height control air circuits or the quick recovery valve circuit.

⚠ CAUTION ⚠

When operating the 102D3 coach with the trailing axles in a non-emergency fully retracted position, refer to the specific federal, state, local and/or provincial laws governing such operation.

NOTE: This slow deflation and rapid inflation sequence of the air spring should allow for proper folding of the bellows to a completely collapse state.

The axles are lifted through separate and independently valved double-convoluted air spring actuator assemblies mounted to each axle arm. The valves can be used to fill and exhaust the lift actuators only, or they may be used in both the unloading and lifting functions of the trailing axles (i.e. exhausting of the suspension bellows only), depending on the specific installation.

⚠ CAUTION ⚠

The manually operated valves must be properly positioned to allow air back through to the bellows after lifting axles.

MAINTENANCE

RADIUS RODS AND TRUSS PIVOT

The lower radius rods maintain the axle longitudinally. The two upper radius rods are offset, forming a wishbone, and maintain the axle both longitudinally and laterally. The upper radius rods also act to limit vehicle roll while turning and are subject to higher loads. Additionally, the suspension truss pivot blocks attached to both upper clamps are fitted with saddle pin type bushing s similar to the radius rods.

The following instructions apply to radius rods and truss pivots used on the trailing axle suspension. Radius rod ends and truss pivots are mounted via mounting tabs on the rubberized saddle pins that act as rod bushings.

Inspection

MCI recommends checking radius rod bushings at 50,000 mile (80,450 km) intervals to determine if the bushings require replacing due to wear. The Magnaflux process is recommended for detecting cracks in the radius rods.

NOTE: Do not rely on visual inspection for determining the serviceability of radius rod and their bushings.

Due to the mounting configuration of the radius rods to the rear suspension supports and rear bogie assembly, special attention should be placed on the inspection of these rods and their saddle pin bushings.

NOTE: If worn bushings are not replaced, excessive wear to other suspension components and tires will result.

Radius Rod Removal

1. Turn battery switch to “Off”.
2. Block trailing axle at the correct ride height.
3. Remove the trailing axle wheels.

NOTE: Removal of trailing axle disc brake and rotor assembly may be required to remove radius rods.

4. Unfasten and remove the upper radius rods from the truss’s top mounting bracket shown in Figure 1.

NOTE: Brace or restrain truss and axle assembly against falling before removing all radius rods.

5. Unfasten and remove the remaining radius rods.

Bushing Removal

A radius rod bushing removal and installation tool is shown on the “SERVICE TOOLS” page at the end of this sub-section.

Trailing axle pivot block bushings and radius rod require the use of special sleeve installation tools 20-388 and 20-389. The replacement saddle pin bushings have metal outer sleeves. Additionally, a 2 inch diameter round bar (for removing pins), and a 7 inch long piece of 3 inch nominal size (schedule 80) pipe will be needed as a press spacer.

NOTE: All tools are to be used in conjunction with a hydraulic press in the removal and installation procedures that follow.

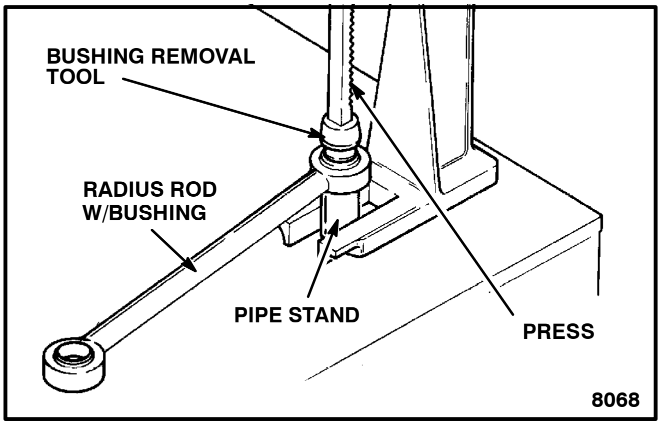


Figure 5. Bushing Removal

⚠ CAUTION ⚠

Support or block components in accordance with good hydraulic press operating procedures.

1. Place radius rod eye or clamp pivot block in press, with saddle pin bushing centered on top of spacer pipe (Figure 5).
2. Place the round bar on top of radius rod or pivot block saddle pin’s mounting tab.
3. Apply pressure with the press until the bushing drops out of the eye and into the pipe. The round bar will drop out also.
4. Remove the radius rod, bushing and round bar from press.
5. Clean the remainder of the bonded rubber residue from inside diameter of the rod eye.

Bushing Installation

1. Coat exterior of new saddle pin bushing with *Never-Seize* compound or equivalent anti-seize compound.

NOTE: Anti-seize compounds are applied only to the bushing’s outer metal sleeve.

2. Place radius rod or pivot block, bushing and appropriate sleeve installation tool in press, centered over spacer pipe (Figure 6).

NOTE: Correct Orientation of the saddle pin tabs in relationship to their mounting must be made before pressing pin into rod eye or pivot block.

3. Apply pressure to top of tool until bushing is centered inside the radius rod eye.

NOTE: Sleeve installation tool has slots to visually inspect seating of saddle pin bushings.

4. Remove tool and radius rod from press.

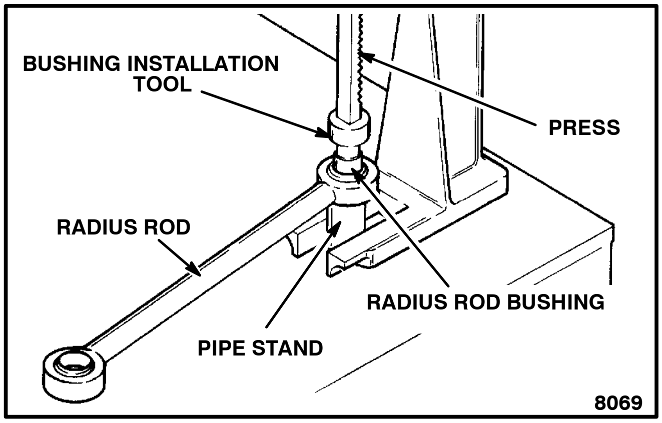


Figure 6. Bushing Installation

Radius Rod Installation

1. Set coach at the correct ride height (Figure 7).
2. Apply a thin coating of anti-seize on all mounting surfaces of the radius rod saddle pins and reinstall to mounting locations.

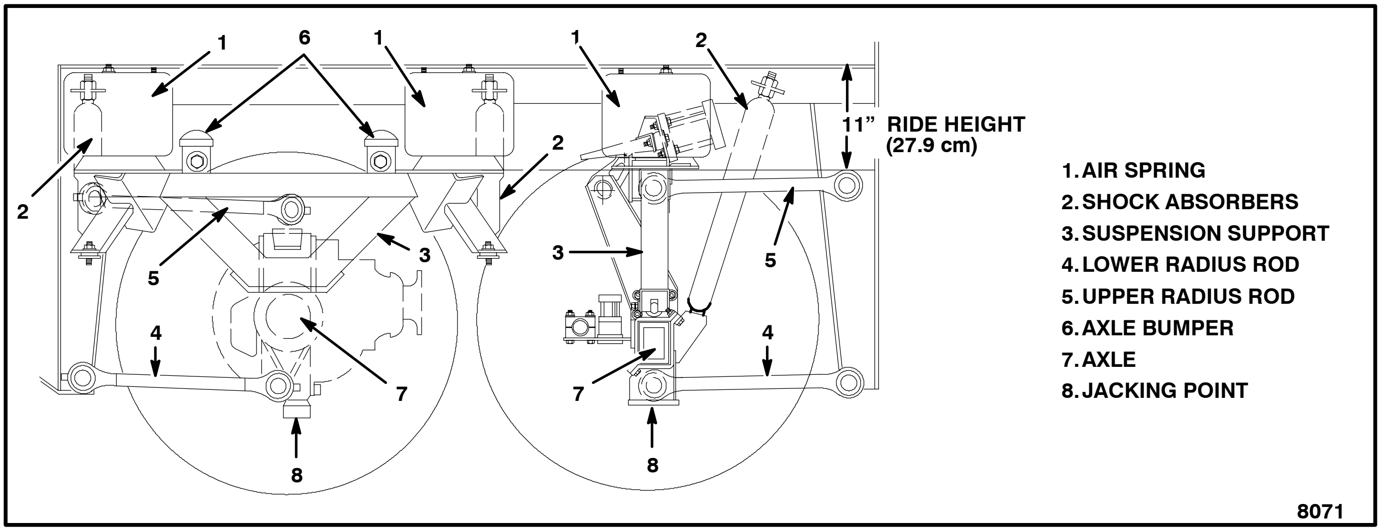


Figure 7. Trailing Axle Suspension

NOTE: Anti-seize is applied only to saddle pin bushing's tab-to-chassis mating points and fasteners.

3. Install fasteners with hex nuts out and torque to 220 ft-lbs (300 N·m).

NOTE: If ride height was compromised during radius rod fit-up, reset before torquing fasteners.

SHOCK ABSORBERS

The main function of the shock absorber is to regulate the vehicle axle travel by dampening the rebound motion. Fluid contained within the shock absorber is forced through a restricted opening by a piston when the suspension air springs are flexed.

The shock absorbers are heavy-duty double-acting type. They are of welded construction and cannot be repaired. Defective shock absorbers must be replaced with new units.

Some early models 102DL3 shock absorbers have stud type mountings at both shock ends. All other models are fitted with shocks that have a stud type mount at the bottom and an eye-ring type mount at the top for horizontal attachment to bogie assembly. Follow the applicable procedures for removing shock absorbers.

Shock Removal (Stud Mount)

1. Turn Battery switch to "Off".
2. Remove the trailing axle wheels.
3. Unfasten and remove hex nut, retaining washers and rubber bushings from both ends of the shock.
4. Collapse shock and withdraw from the rear suspension frame (upper) mount, then lift stud end out of mounting hole of the suspension support (lower).

Shock Removal (Eye-Ring Mount)

1. Follow Steps 1 and 2 of previous removal procedure.
2. Unfasten and remove hex nut, retaining washers and slide shock and conical bushings off shock mounting stud.
3. Follow step 3 of the previous removal procedure for removal of bottom shock mount, then collapse shock and remove from suspension support.

Shock Installation (Stud Mount)

⚠ CAUTION ⚠

New rubber mounting bushings should be used when shock absorbers are replaced. Improper bushing pre-load may result from reuse of old bushings.

1. Wire shock in collapsed position for installation.
2. Install upper stud or eyering end into its mount, and position lower stud end over mounting hole and cut retaining wire.

NOTE: Place inner/upper retaining washers over bushings before installing shocks.

3. Install outer/lower retaining washer and hex nut and torque to attain proper bushing pre-load dimension (Figure 8).

AIR SPRINGS (102DL3)

The trailing axle suspension's air springs should be inspected at regular intervals for any wear marks or cracks.

Two different removal procedures are provided for 102DL3 model coaches, depending on the design of the trailing axle suspension air spring assembly used. The two piece air spring (break-away) design consists of a lower spring assembly and an upper bellows retainer. The one piece air spring design incorporates an upper retainer crimped to the bellows.

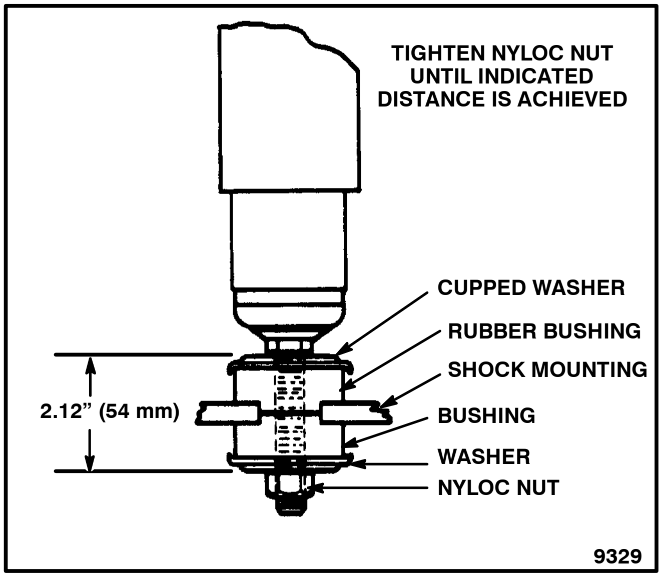


Figure 8. Shock Installation

The two piece (break-away) designs are typically reccognized as having two mounting studs and one air supply tap on the top retainer, whereas the single piece designs have one mount stud and one pipe (air supply tap) mount.

A separate procedure for the 102D3's trailing axle lift actuator air spring is also provided. Follow the procedure's steps for removal and installation in order.

Air Spring Removal (Two Piece)

1. Turn Battery switch to “Off”.
2. Block trailing axle at the correct ride height.
3. Remove the trailing axle wheels.
4. Release air from the rear drive suspension's air springs via the leveling valve.

NOTE: Trailing axle air springs are feed off of the rear suspension.

5. Disconnect the air spring's lower retainer from suspension truss mounting plate.
6. Flex bellows and break-away from top retainer, and remove air spring.

NOTE: Air spring can be removed and replaced with shield in-place.

Air Spring Installation (Two Piece)

1. Install air spring assembly in reverse order of the removal procedure.

NOTE: Make sure that bellows top bead is secured in retainer's lip.

Air Spring Removal (Single Piece)

1. Follow Steps 1 thru 5 of previous removal procedure.
2. Disconnect and remove air supply line, fitting and hex nut (stud side) from top retainer.
3. Collapse air spring bellows and remove.

Air Spring Installation (Single Piece)

1. Install air spring assembly in reverse order of the removal procedure.

AIR SPRINGS (102D3)

Two different removal procedures are provided for 102 model coaches equipped with the retractable trailing axle feature. The procedures for the suspension air spring assembly are different than those procedures used for the lift actuator springs.

The suspension air spring is a two piece air spring (break-away) design, and consists of a lower spring assembly and an upper bellows retainer. The suspension air spring's two piece (break-away) design is typically reccognized as having one mount stud and one pipe (air supply tap) mount on the upper mounting, and one stud on the lower mounting.

The lift actuator air spring is a one piece air spring design, which incorporates an upper/lower clamping ring crimped around the bellows. The lift actuator air spring's one piece design is typically reccognized as having two upper/lower tapped mounting holes and one pipe tap (air supply) mount on the upper mounting.

Air Spring Removal (Suspension)

1. Turn Battery switch to “Off”.
2. Block trailing axle at the correct ride height.
3. Remove the trailing axle wheels.
4. Release air from the rear drive suspension's air springs via the leveling valve.
5. Disconnect the air spring's lower retainer from suspension truss mounting plate.
6. Flex bellows and break-away from top retainer, and remove air spring.

Air Spring Installation (Suspension)

1. Install air spring assembly in reverse order of the removal procedure.

NOTE: Make sure that bellows top bead on the suspension air springs (two piece design) are secured in upper retainer's lip before filling.

Air Actuator Spring Removal (Lifting)

1. Turn Battery switch to “Off”.
2. Remove the trailing axle wheels.
3. Unfasten the air spring’s lower retainer from pivot arm’s mounting pad.
4. Disconnect and remove air supply line and fitting from top retainer.
5. Unfasten the air spring’s upper retainer from rear bogie’s mounting pad.
6. Collapse air spring bellows and remove.

Air Actuator Spring Installation (Lifting)

1. Install air spring assembly in reverse order of the removal procedure.

TRUSS ASSEMBLY

The truss assembly consists of a support truss that incorporates the lower air spring mounting pads. The truss is clamped to the trailing axle by LH/RH upper and lower clamp assemblies. The truss mounts to the upper clamp’s pivot block, which is fitted with a straddle pin bushing. The lower clamp assemblies also provide for the lower shock mounting, and the lower front radius rod mountings. Follow the procedure’s steps for removal and installation in order.

Truss Removal (Axle Attached)

1. Follow the procedures for ”Radius Rod Removal”, ”Shock Removal” and ”Air Spring Removal” as described earlier in this sub-section.

NOTE: Brace or restrain truss and axle assembly from falling after removing radius rods.

2. Disconnect all air lines and electrical harness from the brake assemblies and solenoid control valve and stow out of the way.
3. Remove the axle and truss assembly from under coach.

NOTE: Avoid damage to air spring if still attached to chassis, while removing axle and truss assembly.

4. Unfasten and remove the upper and lower clamp assemblies, and remove truss from the axle assembly.

NOTE: Refer to ”Latch Mechanism Removal” procedure below when removing axle from truss assembly.

5. Unfasten and remove pivot block straddle pin bushing fasteners, and separate upper clamp from truss assembly.

Truss Installation (Axle Attached)

1. Install truss and axle assembly in reverse order of the removal procedure.

NOTE: Refer to ”Latch Mechanism Installation” procedure below when installing axle to truss assembly.

2. Torque truss clamp assembly fasteners to 220 ft-lbs (298 N·m).
3. Torque latching arm (horn) fasteners to 110 ft-lbs (149 N·m).

LATCHING MECHANISM

The latching mechanism is an integral part of the self-steering feature. The latch is actuated by air cylinder, which in-turn retains the bolted on latch arm ”horn” of the axle. The mechanical latch mechanism is mounted to the truss assembly. Periodic inspections of the latch mechanism’s bushings, and clevis adjustment should be made. Follow the procedure’s steps for removal and installation in order.

Latch Mechanism Removal

1. Unfasten and remove the tongue plate from the truss mounting bracket.

NOTE: Inspect tongue mounting bushings and replace if needed.

2. Unfasten and remove latching arm from axle assembly’s saddle mount.
3. Unfasten and remove the air lines and electrical harness to the latching air cylinder.
4. Unfasten and remove the air cylinder (using the “Cylinder Removal” procedure later in this section) and clevis assembly, retain locking plate for assembly.

Latch Mechanism Installation

NOTE: Axle and latching arm (horn), in addition to axle and truss assembly, should be assembled before installation of the latching mechanism is attempted.

1. Reassemble air cylinder and clevis assembly, and install on truss centered over latching arm (horn), resting on arm’s rollers.
2. Torque cylinder and clevis assembly to 25 ft-lbs (33 N·m).

NOTE: Extend clevis slightly to allow installation of tongue plate (approximately .38 inches).

3. Install tongue plate with locking plate, and engage latch arm (horn) into the retaining slot of tongue plate.
4. Tighten tongue mounting bolts to bring (horn) to within 1/16 inch of truss assembly.
5. Reconnect air lines and test actuation of the clevis over tongue plate ramps and clearance of latch arm (horn) to plate.

LOCKING MECHANISM

The air cylinder actuated locking mechanism is mounted on the axle tube. The locking plate is mounted to the tie rod. When locked, self-steering function is not available. Periodic inspections of the locking mechanism's spring and pin. Additional attention should be directed to the locking plate's location and condition.

NOTE: Damage to the locking plate or pin may prevent mechanism from operating properly.

Lock Mechanism Removal

1. Unfasten and remove the air lines and electrical harness to the locking air cylinder.
2. Disconnect dampening shock from locking mechanism's plate assembly mount.
3. Unfasten and remove the locking mechanism's plate assembly from the axle assembly's mount plate.
4. Unfasten and remove the locking plate 's clamp assembly from the tie rod.
5. Unfasten and remove the air cylinder from its mounting boss using the "Cylinder Removal" procedure later in this section.
6. Remove pin and spring and inspect.

Lock Mechanism Installation

1. Install locking mechanism in reverse order of the removal procedure.
2. Torque locking assembly to 110 ft-lbs (149 N·m).

NOTE: Recoat any bare metal areas with a tectyl undercoating.

STEERING DAMPENER

The steering dampener (shock absorber) is mounted between the axle's tie rod and the axle tube, via the locking mechanism's mount plate. The damper assures constant tracking on rough surfaces.

Dampener Removal

1. Disconnect dampening shock from locking mechanism's plate assembly mount.
2. Unfasten and remove damper's clamping mount from tie rod.
3. Unfasten and remove damper from clamp mount.

Dampener Installation

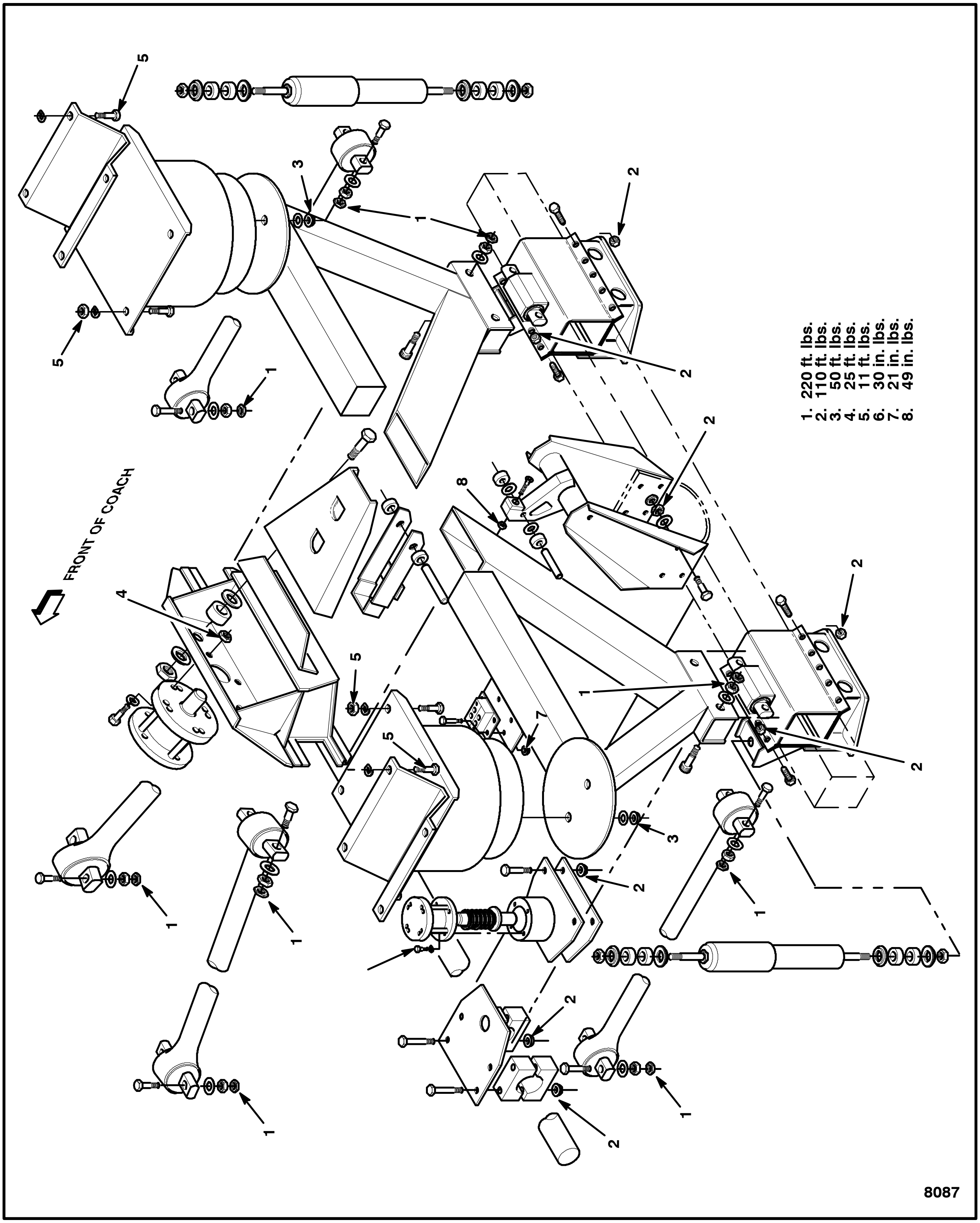
1. Install steering damper in reverse order of the removal procedure.
2. Torque damper clamp assembly to 110 ft-lbs (149 N·m).

NOTE: Set damper at mid-stroke (approximately 11 inches between mount centers) and position clamp on tie rod for installation.

TROUBLESHOOTING

SYMPTOM	DRIVER RESPONSE
1. "STEER" light illuminated, transmission in neutral.	• Turn "ON" override switch. Note whether panel light extinguishes. • Check latch mechanism to verify actuating cylinder position (**extended or retracted**). • If retracted, coach may be driven. Fault should then be rectified at first opportunity. • If extended, coach must be driven in reverse while turning (left or right) past center to ensure tie rod lock engagement ("LOCK" light should illuminate). Coach may then be driven at highway speeds. Fault should be rectified at first opportunity.
2. "STEER" light illuminated, coach in reverse gear.	• If moving, stop coach. Check latch mechanism to verify actuating cylinder position (extended or retracted). • If extended, turn on override switch and observe whether "STEER" light extinguishes and proceed with back-up maneuver, turning left or right past center to lock the tie rod. • Leave override switch on if coach is to be driven until fault is rectified. • If actuating cylinder is retracted turn "ON" override switch, shift into forward gear, observe whether "STEER" light extinguishes, move forward turning left or right past center and stop. With override left "ON" coach may be backed up or driven forward until fault is rectified.
3. "LOCK" light illuminated, coach at speed below 15 MPH	• Turn "ON" override switch. Stop the coach. Observe whether "STEER" light has extinguished. Check latch mechanism to verify actuating cylinder position. • If retracted, move forward and initiate a turn, left or right past center to ensure tie rod is locked. "LOCK" light should be illuminated. • If not, initiate a turn and stop. Visually check that tag axle wheels are held in straight-ahead position. With override switch left "ON", coach may be driven until fault rectification is carried out. • If cylinder is extended (handling abnormality should have been felt) shift into reverse and back up, initiating a turn left or right past center. Check that tie rod is locked. "LOCK" light should be illuminated. • If not, initiate a turn and stop. Visually verify that trailing axle wheels are held in straight-ahead position. With override switch left "ON", coach may be driven. Fault rectification should be carried out at earliest opportunity.
4. "LOCK" light illuminated, coach at speed above 20 MPH	• Turn "ON" override switch. Bring coach to a stop as quickly as possible. Otherwise, take action as for 3. above. (Note: an abnormal position of the actuating cylinder at speed should produce a handling abnormality felt by the driver).

TORQUE SPECIFICATIONS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1. 220 ft. lbs.
2. 110 ft. lbs.
3. 50 ft. lbs.
4. 25 ft. lbs.
5. 11 ft. lbs.
6. 30 in. lbs.
7. 21 in. lbs.
8. 49 in. lbs.

SPECIFICATIONS

SUSPENSION AIR SPRING

Manufacturer	Goodyear, Firestone
Part Number	(Two Piece Design 102DL3) 12L-1-104
Part Number	(Single Piece Design 102DL3) 12L-1-140
Part Number	(Single Piece Design 102D3) 12L-1-142
Type	Rolling Lobe
Diameter	12.8 inches (325 mm)

LIFT ACTUATOR AIR SPRING (102D3)

Manufacturer	Goodyear
Part Number	(Single Piece Design) 12L-4-9
Type	Double Convolute
Diameter	8.0 inch (200 mm)

SHOCK ABSORBER

Manufacturer	Gabriel
Part Number	(Stud Type 102DL3) 12L-5-72
Part Number	(Eye-Ring Type 102D3) 12L-5-98
Collapsed Length	(102DL3) 20.72 inches (526 mm)
Extended Length	(102DL3) 33.25 inches (844 mm)

STEERING DAMPENER (102DL3)

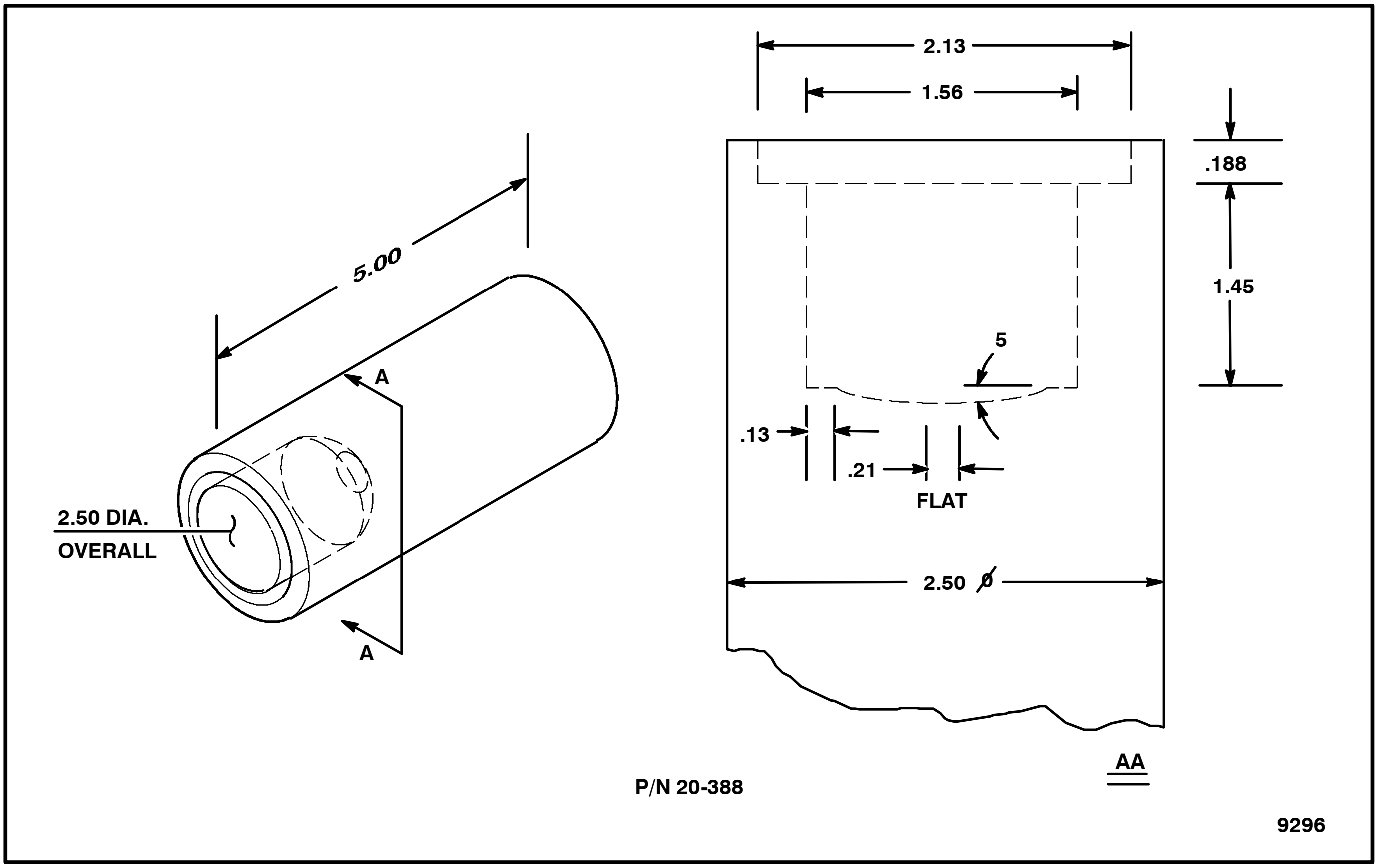
Manufacturer	Gabriel
Part Number	(Stud Type 102DL3) 12L-4-170
Collapsed Length	8.97 inches (227 mm)
Extended Length	12.96 inches (329 mm)

RADIUS RODS (102DL3)

Manufacturer	Clevite
Part Number	(Upper 102DL3) 12L-4-135
Part Number	(Lower 102DL3) 12L-4-134

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.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Install and Removal Tool for 12L-4-115 (Pivot Bushing)

SECTION 12E

SUSPENSION CONTROL SYSTEMS

CONTENTS OF THIS SECTION

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General Description 12E-1
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GENERAL DESCRIPTION

Several different types of suspension control systems can be installed on the D series model coaches. Some of the components described in this section are basic suspension control and protection devices. Some of the optional features available may have a series of control valves and regulating devices depending on the particular system chosen.

All coaches are fitted with special auto-leveling height control valves at the front and rear drive axle suspension systems. The valves control the inflation and exhausting of all suspension air springs to maintain correct coach ride height. These valves are also used in conjunction with other optional features to enhance or modify the vehicle suspension system.

All coaches have the trailing axle unloading feature that allows for partial unloading of the trailing axle. The unloading feature can place approximately 2,000 additional pounds of weight on the drive axle during adverse road conditions. The manual or solenoid operated unloading valves work in conjunction with the basic leveling valve system. The unload system is protected by a low air switch and alarm circuit.

All 102DL3 model coaches are equipped with a self-steering trailing axle system. The variable caster function of this axle installation allows for greater maneuverability. Self-castering is achieved by rotating the axle in pitch (above the lateral axis) This pivoting action about the spindle provides a caster from 3 degrees positive (forward motion) to 3 degrees negative (reverse travel). The latching mechanism retains the bolted on ”horn” (catch) of the axle.

The 102D3 models feature a liftable swing-arm type axle configuration that works in combination with either the manual or the optional electrically controlled tag axle unloading system. If specified, both of these features can be actuated (by separate switches) from the driver’s dash. An optional direct air (quick) recovery system is also available to re-inflate the suspension bellows.

Additionally, some coaches may be equipped with a driver actuated kneeling feature, which allows the coach front suspension to lower 3 to 6 inches from normal ride height to board passengers and then to raise for normal travel. The kneeling feature works in conjunction with the basic coach leveling system.

NOTE: Effective with unit 48920 coaches use a slightly different kneeling system configuration and operating arrangement.

A rear Hi-Rise feature was installed to prevent rear bumper scuffing in off-highway situations. This feature provides increased air pressure to the drive axle air springs which raises the coach approximately three inches above normal ride height allowing additional rear body clearance.

COMPONENTS

HEIGHT/LEVELING CONTROL SYSTEM

The coach is equipped with one leveling valve mounted to the front bogie for front suspension, and two valves mounted to the channel assembly above the rear axle for the rear suspension. Valves are connected to the coach axles by a link assembly which is attached to the valve’s control arm (over-travel lever). Pressurized air is supplied to the front and rear leveling valves from the suspension/accessory junction blocks.

TAG UNLOADING SYSTEM (MANUAL)

The basic trailing axle unloading feature is operated through two Watts full port, two-position, manual dump valves. These valves are located on the inside front frame of the RH rear side service door. These valves are supplied by the rear leveling valve circuit, through the drive axle air spring supply lines.

TAG UNLOADING SYSTEM (ELECTRIC)

The optional electrically actuated unloading system uses two three-port, two-position, solenoid operated, normally open Skinner valves and incorporates a 40 p.s.. regulator setup located on the inner RH wheel well panel. The system also utilizes the basic manual unloading valve installation. A driver actuated switch is mounted on the RH switch panel. The electrically operated unloading feature can also be incorporated with a trailing axle retracting (lifting) system.

TAG LIFTING SYSTEM

The optional electrically actuated unloading system uses one Norgren normally-closed, air-piloted, three-port, two-position, solenoid operated valve and one Norgren normally-open, air-piloted, five-port, two-position, solenoid operated valve located on the RH inner wheel well panel. The system also utilizes the basic manual unloading valve installation. On some installations the lift switch may be located at rear or mounted on the switch panel.

The electrically operated lifting feature can also be incorporated with a trailing axle unloading system. In this system configuration four Parker normally-closed, three-way, three-port inline valves are used in conjunction with a 40 psi. regulator inside an enclosure mounted to the RH inner rear wheel well. The lift switch is located on rear enclosure box.

QUICK RECOVERY SYSTEM

The optional electrically operated quick recovery system uses one Skinner two-port, normally-open solenoid operated quick recovery valve and one 85 psi. pressure switch located on the channel assembly above the rear axle. The system also utilizes two one-way check valves. This system is used in conjunction with the trailing axle lifting and unloading features and is automatically controlled.

SELF STEERING SYSTEM

The self-steering system’s castering function is automatically controlled through coach direction of travel (i.e., back-up lamp circuit), and locking function controlled by the Foster speed switch located in the front junction box. The system uses twin Norgren five-port, four-way, two-position solenoid valves on a single manifold arrangement. The valves are located on the LH engine compartment wall adjacent to the rear junction box. The system also utilizes two Bimba dual-acting locking and latching air cylinders located on the trailing axle assembly. An emergency override switch is located on the lower LH switch panel. The manual or electrically operated trailing axle unloading feature is available with the self-steering system.

KNEELING FEATURE

Prior To Unit 48920

The old style driver activated kneeling feature is composed of one two-way normally closed Skinner fast recovery valve, one three-way dual-solenoid Humphrey exhaust control valve and a two-way manual level control valve, a 30 psi pressure activated switch, two handle operated ball valves and a 20 psi pressure protecting regulator valve. An override switch is also provided to deactivate the kneel feature. These components are installed in a control box located in the #1 baggage bay. A three-position momentary-on switch is located on the RH switch panel and on the exterior of coach for normal operation this feature.

Effective With 48920

The new style driver activated kneeling feature is composed of an additional RH leveling valve, two double check valves (in assembly) and an R-12 relay valve mounted in the front bogie area. Two three-way Skinner valves (Sol-1 & Sol-2), one pressure protection valve (PPV), two status pressure switches (PS-1 and PS-3 set at 3 psi), and one recovery cut-off pressure switch (PS-2 set at 30 psi) These components along with some miscellaneous electrical components are installed in a control box located in the #1 baggage bay.

REAR RISE FEATURE

The major components consist of one Skinner solenoid control valve, a pressure protection valve (set at 80 psi) and a pressure reducing valve. The valves are mounted on the rear rise air tank located inside the engine compartment near the RH wheelhousing. Two two-way check valves and one R-12 relay valve are mounted on the brake component channel above the drive axle. The rear rise switch is located on the lower LH switch panel.

NOTE: In later models this feature is electrically controlled through the trailing axle’s speed control switch.

PRESSURE PROTECTION SYSTEM

Suspension air spring bellows supply pressure is protected by a normally closed, two port non-exhausting pressure control valve located in the central heat compartment. This valve isolates the suspension leveling valves in the event of a low air condition. This pressure protection valve is set to close at 65 psi and to open at 75-80 psi (Effective with 48314, this valve is set to close at 80 psi and to open at 95 psi).

The kneeling and the rear rise features also have pressure protection valves to protect their individual systems. The kneeling PPV is set to close at 20 psi to prevent complete bellows deflation. The rear rise utilizes a valve set to close at 80 psi.

SUSPENSION FILTER SYSTEM

Several different filters are installed in the suspension air lines to prevent any rust or dirt particles from entering valves or other components of the system. The main suspension filter is mounted adjacent to the secondary air reservoir on earlier models, and connected to the wet tank supply port on late model coaches. Other in-line filters are located upstream from the leveling valves.

OPERATION

HEIGHT & LEVELING CONTROL SYSTEM

The three stages of leveling valve operation are detailed as follows (Figure 1). For further information, refer to the typical leveling valve installation (Figure 2).

Loading

As the coach is loaded the chassis of the coach settles down onto the air spring suspension. Since the valve is mounted to the vehicle chassis and the over-travel arm linked to the the axles, the the valve's moves downward with the body during loading. As the over-travel lever is pushed up and control shaft is rotated, the intake valve lever presses against the pin of the valve core. As the pin is depressed, air pressure flows through the height control valve into the air springs. Increased air pressure expands the air springs and raises the body of vehicle. The intake valve is protected by a check valve which permits air to travel in one direction only.

Neutral

Increased pressure expands the air springs lifting the vehicle body and height control valve. The over-travel lever returns to "neutral" as vehicle body approaches normal ride height. The intake valve lever also moves the closing valve. The exhaust valve remains closed and the check valve in intake adapter prevents air from escaping from the valve body and air springs. This condition remains static until coach load is altered, moving the over-travel lever from "neutral" for one or more seconds actuating the intake or exhaust valves. Over-travel lever incorporates an internal spring mechanism that returns lever to the neutral position.

Unloading

When the load is lightened, pressure in the air springs raises the coach body. Over-travel lever is pulled downward from "neutral." This applies a force that slowly moves the delay piston and opens the exhaust valve when the lever moves beyond free travel range. The intake valve remains closed allowing air from the air springs to exhaust to atmosphere. As air is exhausted from air springs, the vehicle body is lowered until the overtravel lever returns to neutral position.

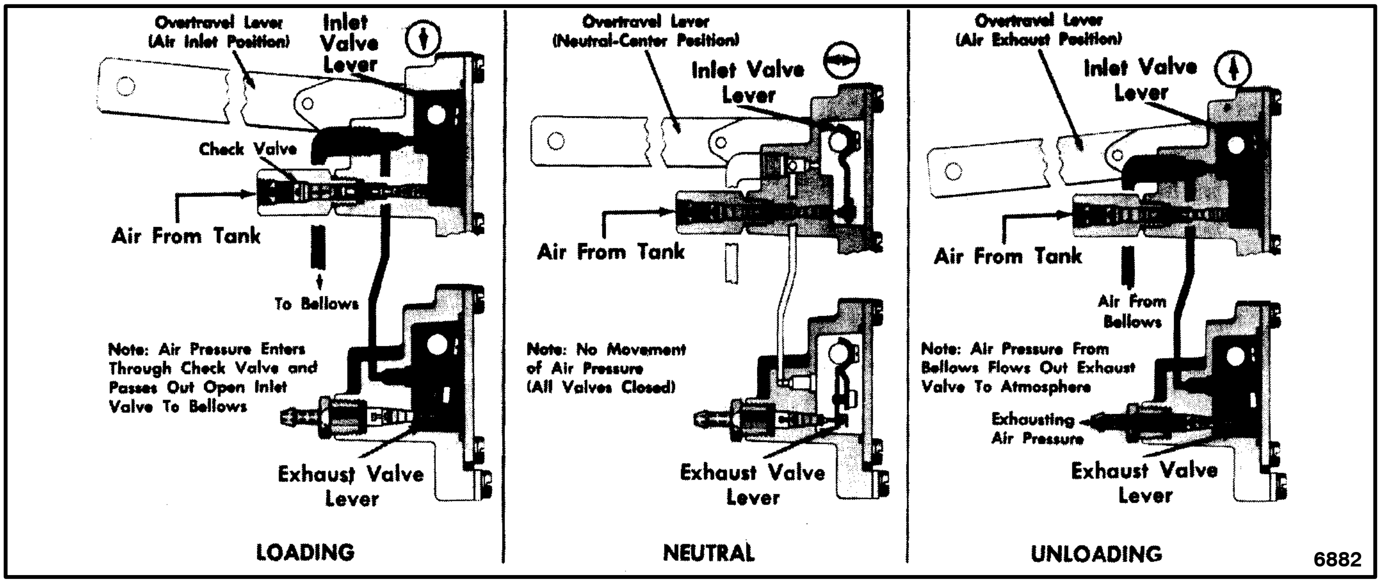

Overtravel Lever (Air Inlet Position)
Inlet Valve Lever
Check Valve
Air From Tank
To Bellows
Note: Air Pressure Enters Through Check Valve and Passes Out Open Inlet Valve To Bellows
Exhaust Valve Lever
LOADING
Overtravel Lever (Neutral-Center Position)
Inlet Valve Lever
Air From Tank
Note: No Movement of Air Pressure (All Valves Closed)
Exhaust Valve Lever
NEUTRAL
Overtravel Lever (Air Exhaust Position)
Inlet Valve Lever
Air From Tank
Air From Bellows
Note: Air Pressure From Bellows Flows Out Exhaust Valve To Atmosphere
Exhausting Air Pressure
Exhaust Valve Lever
UNLOADING
6882

Figure 1. Height Control Valve Operation

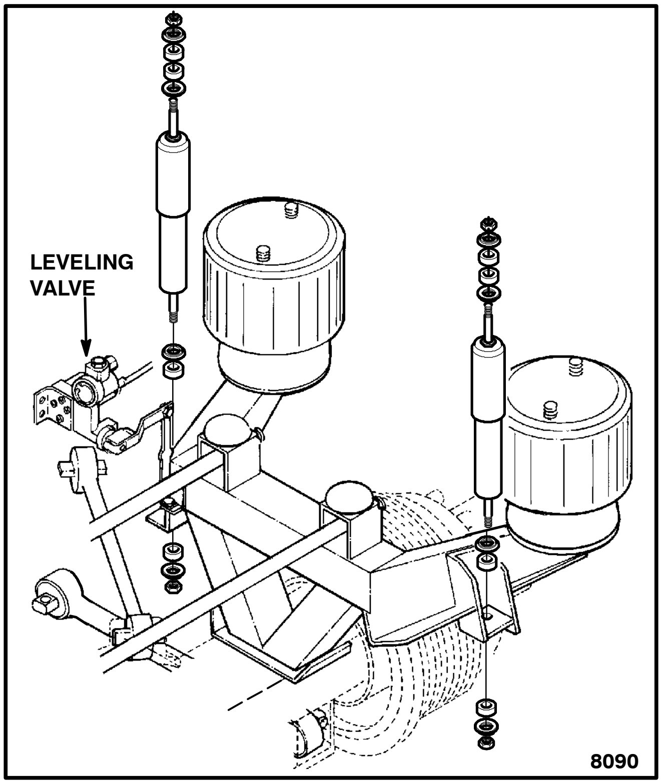


Figure 2. Rear Leveling Valve Link Installation

When the coach is in motion with body at normal ride height, the over-travel lever is in neutral position. Small movements of the lever may occur without activating the control valve as it must move in excess of $\frac{3}{16}$-inch (4.7 mm) before either the inlet or exhaust valve is opened.

The delay piston, connecting through a pin to over-travel shaft is contained in a cylinder of silicone fluid. The slowing action of this fluid delays by 1-6 seconds the closing of one valve to the opening of the other. The flapper valves allow both valves to close from full-open position within 1 second.

The over-travel piston is held against the shaft by two springs (one inside the other) and keeps the shaft in proper position relative to the over-travel lever. The purpose of the piston is to prevent damage of parts inside the control valve if the lever exceeds normal travel, and to allow the lever to move without moving parts inside the valve.

AXLE UNLOADING SYSTEM

Manual Operation

The unload function is accomplished by positioning the tag axle unloading valves to the exhaust (horizontal) position. When the valves are positioned in this manner air supply from the leveling valves to the drive axle bellow is blocked. The exhaust port is open to the trailing axle suspension bellows, which slowly exhaust through the valve (Figure 3). Returning the valve handles to the load (vertical) position will reinflate the air springs.

⚠ CAUTION ⚠

The manually operated valves can completely unload the trailing axle.

Electric Operation

When the driver actuated switch is positioned to unload “UP”, the two normally open solenoid valves close and allow the exhaust port open to delivery. Suspension bellows air escapes out the exhaust port of the Skinner valve and through the delivery side of the 40 psi regulator. The normal 65-70 psi bellows pressure is exhausted down to 40 psi

NOTE: The electrically actuated trailing axle unloading system will not allow the trailing axle to be completely unloaded.

With the switch repositioned to load trailing axles “DOWN”, the Skinner valve opens supply port to delivery. Supply air from the rear leveling valve circuit flows through the solenoid valve to the manual unloading valves. The manual valves are in the open or load (vertical) position and allow air to enter the trailing axle air springs.

AXLE RETRACTING SYSTEM

Without Unloading Feature

By positioning the control box or dash switch to lift “UP” both of the normally-closed Norgren three-port solenoid operated valve is opened. Port #2 is open to port #1 and exhausts LH trailing axle bellows, while port #3 blocks supply from LH rear drive bellows. Simultaneously, the normally-open Norgren five-port valve is closed, allowing port #4 open to exhaust RH trailing axle bellows through port #1, while port #5 blocks supply from RH rear drive bellows. Exhaust air is routed through the manual trailing axle dump valves, which are in the open or load (vertical) position.

NOTE: Sufficient air pressure must exist in the air/fuel junction block circuit for the Norgren valves to operate.

While suspension bellows exhausting, port #3 of the five-port valve is opened to port #2. This allows supply air from the rear air/fuel junction block to flow to the LH/RH lift actuator spring bellows (Figure 4). Inflation of the actuator spring helps deflate the trailing suspension’s air spring bellows.

The Norgren valves can be manually actuated during electrical circuit or solenoid failures by pushing in on the override button located below solenoid. This procedure changes the internal spool position.

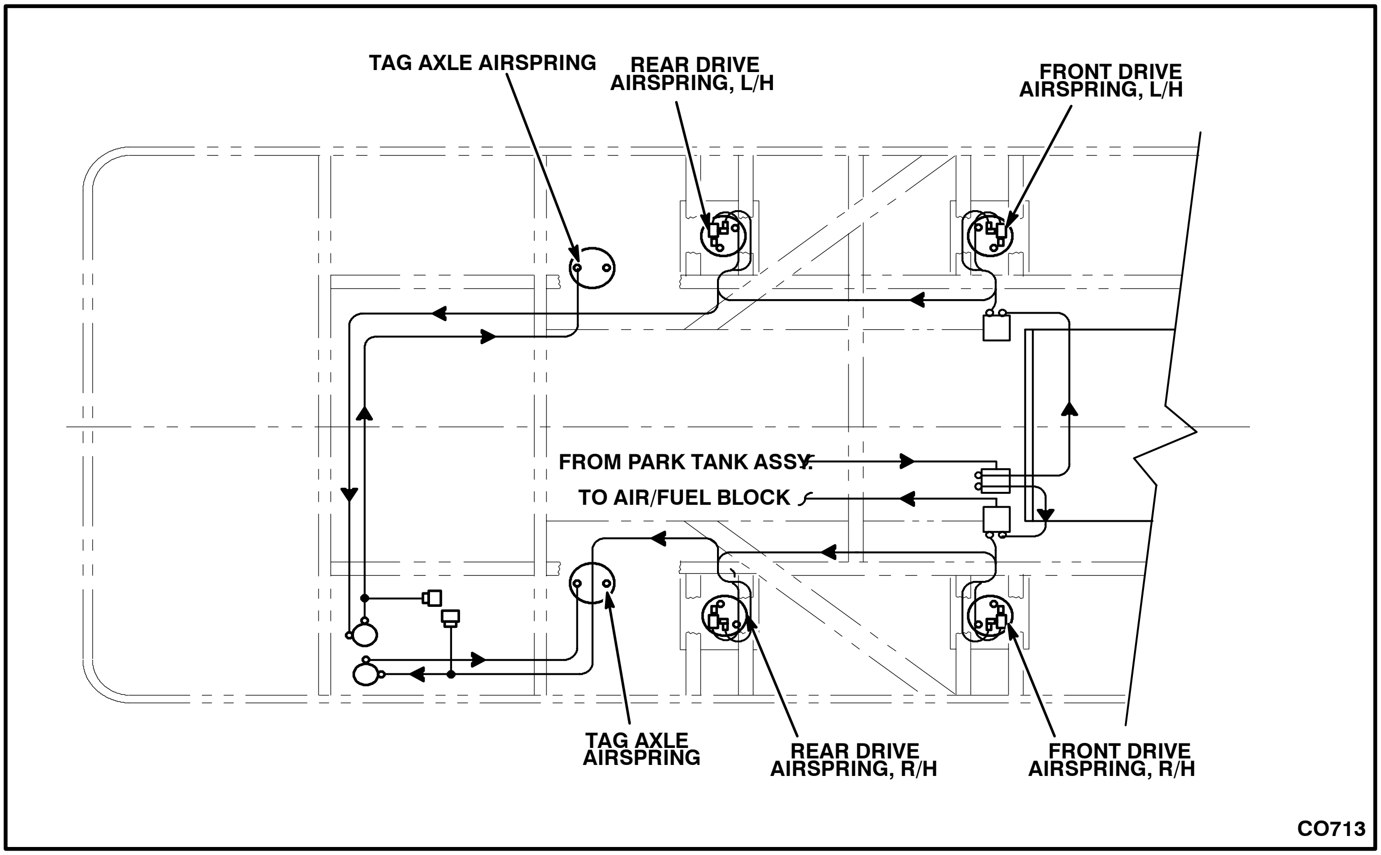

TAG AXLE AIRSPRING
REAR DRIVE AIRSPRING, L/H
FRONT DRIVE AIRSPRING, L/H
FROM PARK TANK ASSY.
TO AIR/FUEL BLOCK
TAG AXLE AIRSPRING
REAR DRIVE AIRSPRING, R/H
FRONT DRIVE AIRSPRING, R/H
CO713

Figure 3. Tag Axle Unloading Air Circuit

With the switch repositioned "DOWN" to extend trailing axles, port #3 on the three-port valve is open to port #2, and port #5 on the five port valve is open to port #4, allowing supply from LH/RH rear drive bellows to reinflate the suspension air spring. While the suspension bellows inflate port #2 of the five-port valve is opened to port #1. This allows air from the actuator bellow to exhaust, while port #3 blocks supply air.

With Unloading Feature

By positioning the control box lift switch to lift "UP" all four of the normally-closed Parker three-port solenoid operated valves (A), (B) and (C) are energized and opened. Port #2 is open to port #1 on (A) and supply air from the air/fuel junction block is routed to the trailing axle lift actuator springs. Port #2 is open to port #1 on (B) and (C) while port #3 is blocking LH/RH drive bellows supply air. Ports #1 on (B) and (C) are routed to port #2 of valve (D), which is de-energized and open to port #3. This allows the trailing axle suspension air springs to exhaust completely while the lift actuators fill (Figure 5).

When the switch is repositioned to extend axles, valves (A), (B) and (C) are de-energized. Port #1 of valve (A) is open to port #3 and exhausts both actuator air spring bellows, while port #1 blocks actuator supply air. Port #3 of (B) and (C) is opened to port #2 allowing supply air from the RH/LH drive bellows to fill both trailing axle suspension air spring bellows via the manual dump valve's open circuit.

When the driver actuated switch is positioned to unload "UP", valves (B), (C) and (D) are energized and port #1 is open to port #2, which partially exhausts the LH/RH trailing axle bellows through the regulator valve. Port #3 blocks supply from RH/LH rear drive bellows of valves (B) and (C). When the switch is repositioned to load axles, valves (B), (C) and (D) are de-energized. Port #3 is open to port #2 allowing supply from RH/LH rear drive bellows to refill the trailing axle suspension bellows. Port #1 of (D) blocks supply from the air/fuel junction block.

QUICK RECOVERY SYSTEM

Whenever the lift or unload switches are actuated the quick recovery system is energized and operates automatically. As air pressure drops 85 psi during a lifting or loading operation, the pressure switch closes and completes a circuit to the quick recovery valve which opens (Figure 6). The valve allows supply air from the suspension/accessory air junction block to flow directly to the rear and trailing axle air springs by-passing the rear leveling valve circuit. As pressure builds above 85 psi the pressure switch opens and the quick recovery valve closes. Final pressurization of the air springs is accomplished through the normal leveling valve circuit.

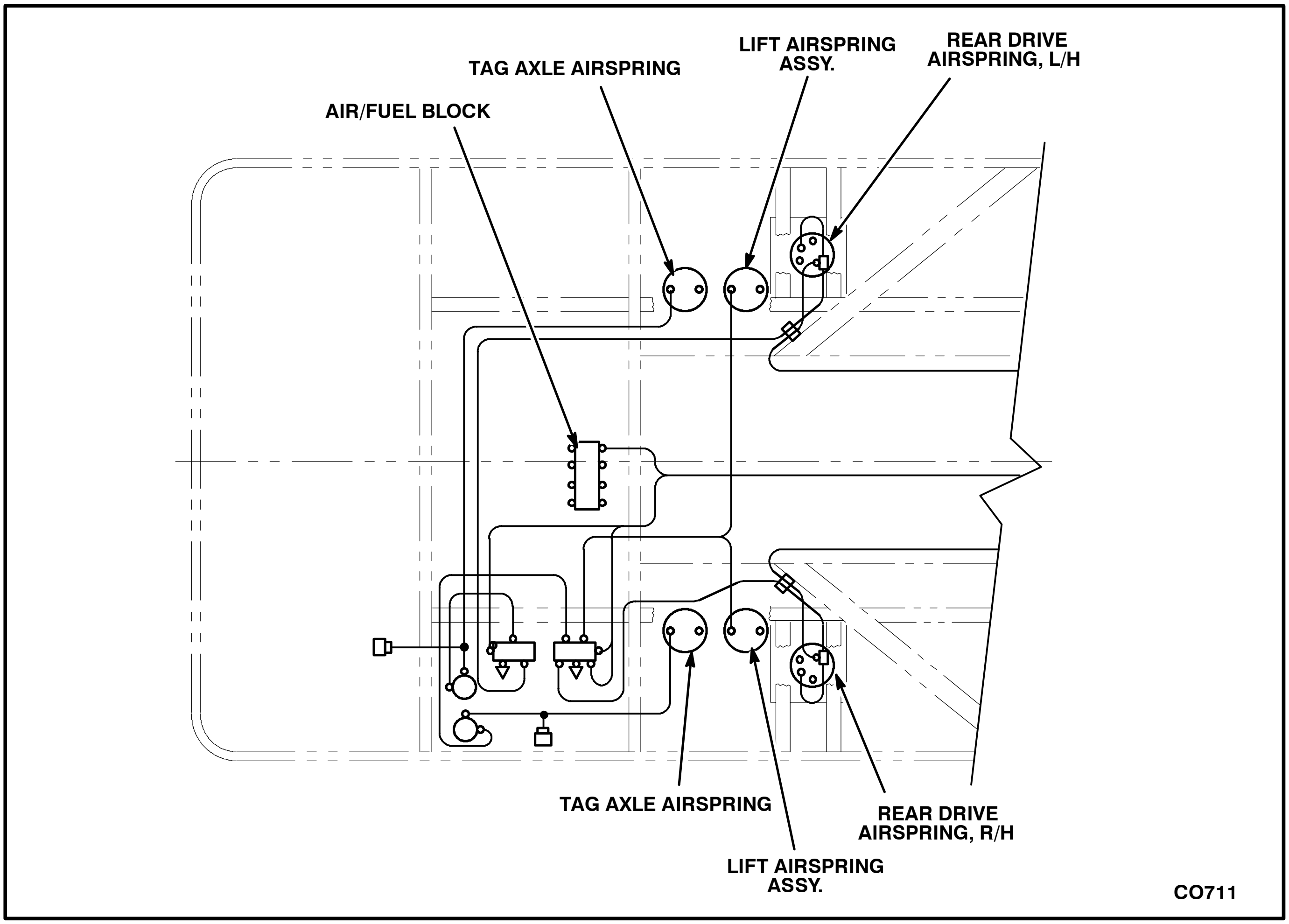


Figure 4. Tag Axle Lifting Air Circuit

SELF STEERING SYSTEM

Normal Operation

All castering and normal locking functions of this system are electromechanically performed through actuation of the Bimba air cylinders and Norgren solenoid valves. The system's operation is sequential, with auto locking and unlocking controlled by the coach speed switch and auto forward/reverse latching and unlatching controlled by the back-up lamp circuit.

The locking solenoid valve supply port #1 is open to port #2 when valve is not energized. The speed switch's normally-closed 24 volt output side energizes when coach is started. This opens the valve supply port #1 to port #4, which deliveries air to the retract side of the air cylinder. The extend side of the air cylinder is exhausted through port #3 unlocking the trailing axle (Figure 7).

NOTE: The automatic self-steering feature is equipped with a manually operated override switch "TAG LOCK". When actuated it opens the speed switch output side's ground, which will keep the solenoid valve circuit de-energized until the switch is repositioned.

The switch de-energizes the solenoid valve when the coach reaches the 20 MPH setpoint. This opens port #4 to exhaust port #5, while opening port #1 to port #2, allowing air to enter the extend side of the air cylinder and lock the trailing axle. Secondly, actuation of the castering mechanism is controlled via transmision gear selection (i.e., back-up light circuits) for reverse travel.

NOTE: The speed switch's normally-open output side is used to energize the locking cylinder reed switch circuit.

The latching solenoid valve supply port #1 is open to port #2 when valve is not energized. The valve is energized when coach is placed in reverse and back-up lamp circuit is energized. This opens the valve supply port #1 to port #4, which deliveries air to the extend side of the latching air cylinder. The extend side of the air cylinder is exhausted through port #3 unlocking the trailing axle.

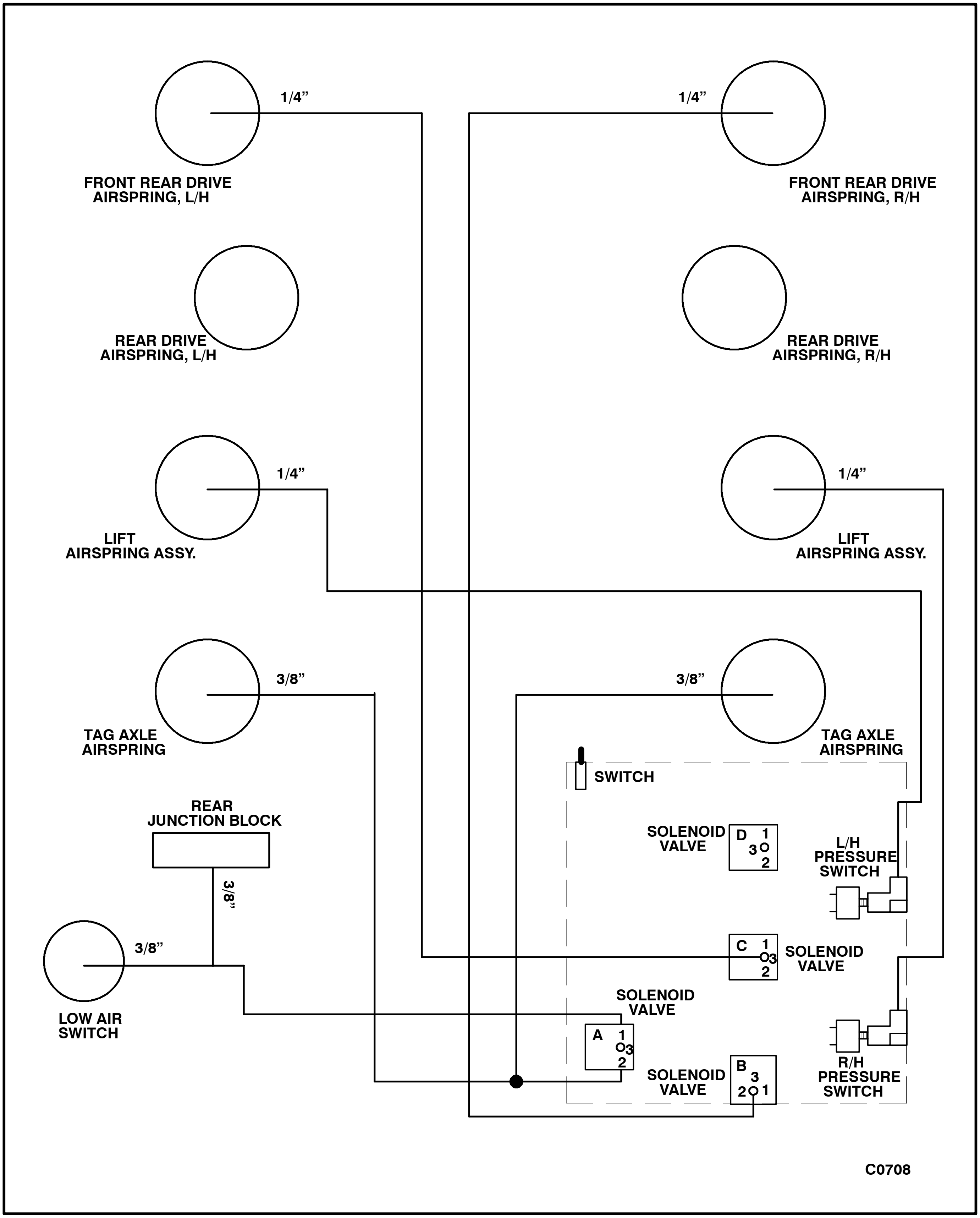

1/4"
FRONT REAR DRIVE AIRSPRING, L/H
1/4"
FRONT REAR DRIVE AIRSPRING, R/H
REAR DRIVE AIRSPRING, L/H
REAR DRIVE AIRSPRING, R/H
1/4"
LIFT AIRSPRING ASSY.
1/4"
LIFT AIRSPRING ASSY.
3/8"
TAG AXLE AIRSPRING
3/8"
TAG AXLE AIRSPRING
SWITCH
REAR JUNCTION BLOCK
3/8"
SOLENOID VALVE
D 1 3 2
L/H PRESSURE SWITCH
3/8"
LOW AIR SWITCH
C 1 3 2
SOLENOID VALVE
SOLENOID VALVE
A 1 3 2
SOLENOID VALVE
B 3 2 1
R/H PRESSURE SWITCH
C0708

Figure 5. Tag Axle Lifting/Unloading Air Circuit

Fault Operation

The two warning lights are located in the left-hand telltale and are identified as "TAG STEERING" and "TAG LOCKED". Tell-tale lights indicate a system fault or malfunction. If the tell-tale light for "TAG STEERING" comes on and stays illuminated, it would indicate that the trailing axle is set in the wrong position for the direction of travel.

⚠ CAUTION ⚠

In the above case the coach should be stopped immediately. If castering mechanism fails to release for forward travel and remains in reverse do not drive the coach in the forward direction. Driving may cause trailing axle suspension and/or tire damage.

If the "TAG LOCKED" warning lamp illuminate and remains on, it would indicate either the axle is unlocked above 20 mph or that the axle is locked below 15 mph.

The manual override switch is located on the lower left-hand switch panel and labelled "TAG LOCK". This switch manually locks the trailing axle and deactivates the buzzer, yet leaves the warning lights "ON". This indicates to others that a problem exists with the trailing axle, and also that the axle is locked in the forward position and is still draftable.

NOTE: This switch will not override a problem associated with a tag steering warning as noted above.

The Norgren valves can be manually actuated during electrical circuit or solenoid failure by turning the RED solenoid override button counter-clockwise to (1). This procedure changes delivery port #2 to port #4.

KNEELING SYSTEM

Normal Operation (Prior To 48920)

During normal coach operation the manual level control valve is open. This allows basic leveling valve system supply air to flow to the exhaust control valve. The exhaust valve's top solenoid is energized with supply port open to delivery. Air flows through the pressure protecting regulator valve to the LH/RH front air spring bellows.

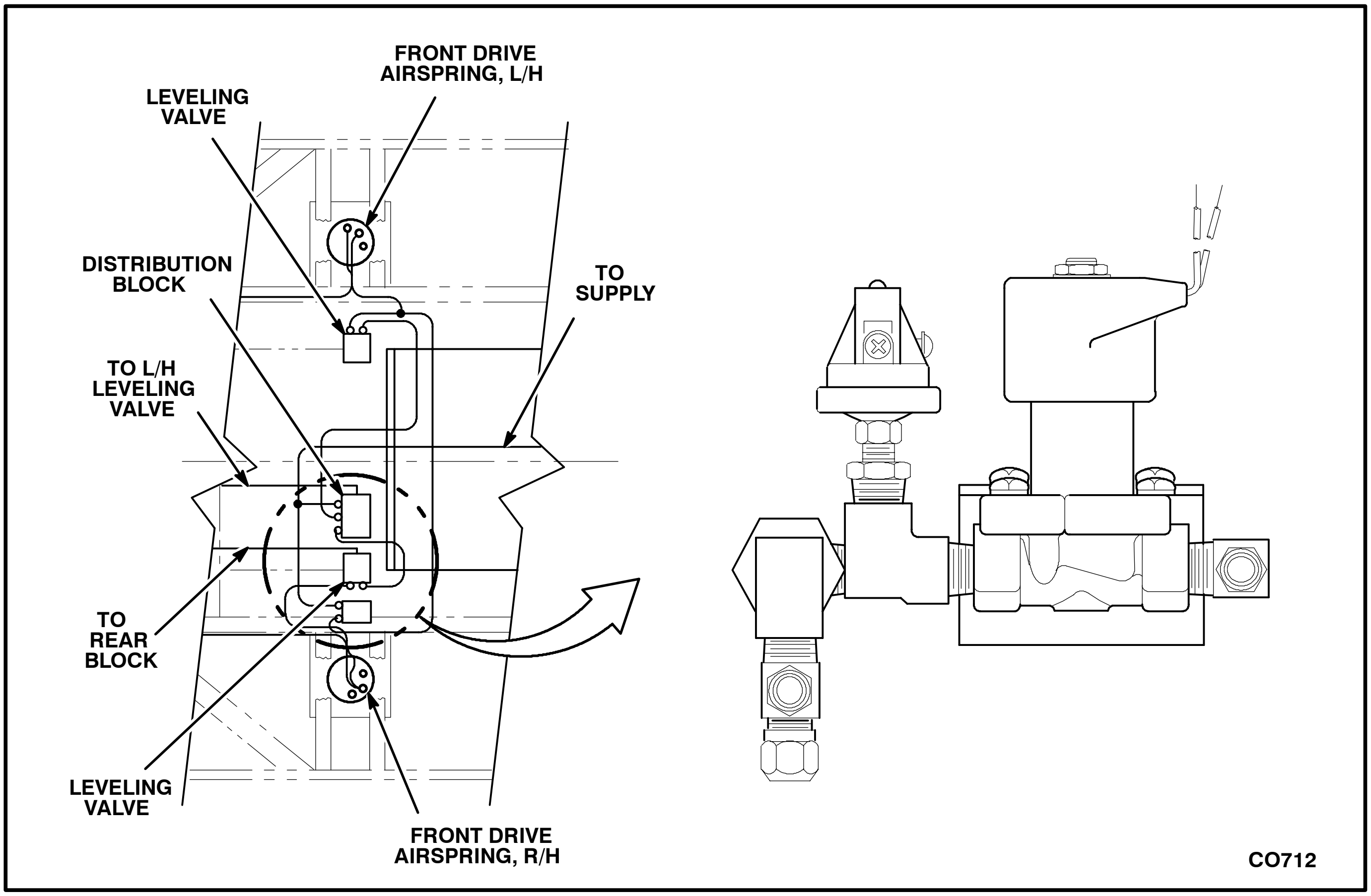


Figure 6. Quick Recovery Circuit

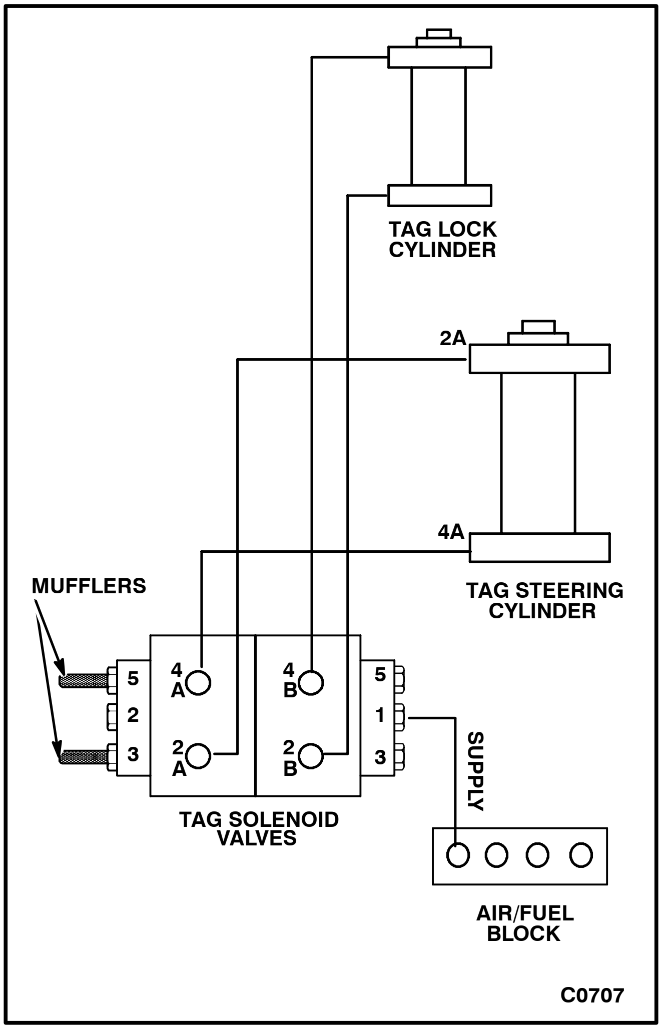


Figure 7. Tag Axle Self-Steering Air Circuit

NOTE: The exhaust control valve's top solenoid is energized through the kneel interlock relay.

Kneel Function (Prior To 48920)

When the driver actuated switch or exterior switch is positioned to "KNEEL" and released, the valve's bottom (kneel) solenoid is energized. This opens the delivery port to the exhaust port and exhausts the front suspension air springs by way of the pressure protection valve. As air pressure drops below 50 psi the pressure switch closes, and energizes the normally-closed fast recovery valve. The air springs should exhaust down to approximately 20 psi before the pressure protecting regulator valve closes (Figure 8).

Rise Function (Prior To 48920)

When the switch is repositioned to "UP" and released, the exhaust control valve's top (up) solenoid is again energized. This allows air from the wet tank to flow through the fast recovery valve through the exhaust control valve and out to the front suspension air spring bellows. As pressure builds above 52 psi in the LH bellows pilot line, the pressure switch should open. When this switch opens, it de-energizes the fast recovery valve and closes the wet tank supply air. The front air springs should continue to fill through the basic leveling valve circuit until correct ride height is attained.

Override Operation (Prior To 48920)

During emergencies the kneeling feature may be by-passed by positioning the manual level control valve to the "EXHAUST". This allows normal leveling valve circuit supply air to flow directly to the front air springs, by-passing the exhaust control valve. During extended periods of non-use, the manual isolating ball valves may also be closed by positioning them to their "OFF" (horizontal) position.

Normal Operation (Effective With 48920)

During normal coach operation two pressure switches sense LH/RH bellows pressure, and should be closed allowing system to be electrically enabled. Air from the suspension system's reservoir enters both LH/RH leveling valves. The supply air is routed via the LH leveling valve only to the normally open solenoid valve (Sol-2), then through the dual double check valve assembly to the air springs. Control air from the wet tank is blocked by the closed solenoid valve (Sol-1). Refer to the "Normal Leveling Mode" of the operations chart (Figure 9).

NOTE: Pressure switches (PS-1 & PS-3) must sense a minimum of 3 psi from both LH/RH bellows to allow the kneeling feature's electrical system to be enabled. The kneel system is automatically disabled if a low air condition exists in either of the air spring bellows. The pressure protection valve is also set to close at 20 psi to protect the system.

Kneel Function (Effective With 48920)

When the momentary-on switch is positioned to "KNEEL" and then released, normal bellows air supply is blocked by the closing of solenoid valve (Sol-2). The kneel solenoid valve (Sol-1) is energized briefly and opens to allow the double checks to be reset for exhaust cycle.

NOTE: The higher pressure wet tank supply air (above 75 psi) is routed through the opened solenoid valve (Sol-1) (port 2 & 3), which pressurized the R-12 relay valve control port.

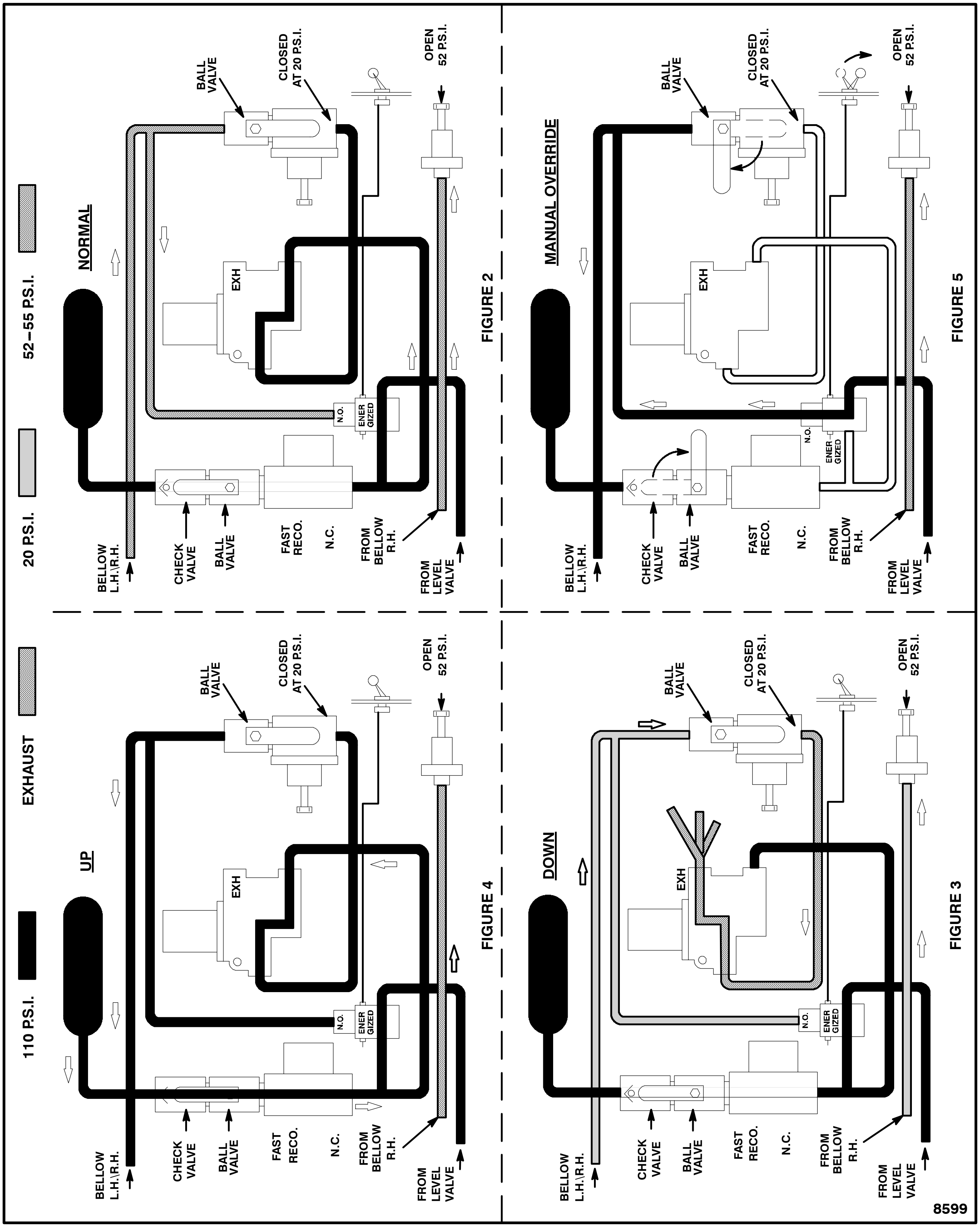

20 P.S.I.
52 – 55 P.S.I.
110 P.S.I.
EXHAUST
NORMAL
FIGURE 2
BALL VALVE
CLOSED AT 20 P.S.I.
OPEN 52 P.S.I.
EXH
N.O.
ENERGIZED
BELLOW L.H.\R.H.
CHECK VALVE
BALL VALVE
FAST RECO.
N.C.
FROM BELLOW R.H.
FROM LEVEL VALVE
MANUAL OVERRIDE
FIGURE 5
BALL VALVE
CLOSED AT 20 P.S.I.
OPEN 52 P.S.I.
EXH
N.O.
ENERGIZED
BELLOW L.H.\R.H.
CHECK VALVE
BALL VALVE
FAST RECO.
N.C.
FROM BELLOW R.H.
FROM LEVEL VALVE
UP
FIGURE 4
BALL VALVE
CLOSED AT 20 P.S.I.
OPEN 52 P.S.I.
EXH
N.O.
ENERGIZED
BELLOW L.H.\R.H.
CHECK VALVE
BALL VALVE
FAST RECO.
N.C.
FROM BELLOW R.H.
FROM LEVEL VALVE
DOWN
FIGURE 3
BALL VALVE
CLOSED AT 20 P.S.I.
OPEN 52 P.S.I.
EXH
N.O.
ENERGIZED
BELLOW L.H.\R.H.
CHECK VALVE
BALL VALVE
FAST RECO.
N.C.
FROM BELLOW R.H.
FROM LEVEL VALVE
8599

Figure 8. Kneeling System

After the check valves have been repositioned, the LH/RH bellows should exhaust quickly through the R-12 relay's bottom exhaust port. This exhaust is also monitored by the pressure protection valve via the R-12's control line and closed solenoid valve (Sol-1) (port 1 & 3) to prevent complete exhausting of the bellows. At approximately 20 psi the pressure protection valve closes, equalizing the R-12 valve's exhaust port and leaves the LH/RH bellows deflated. Refer to the "Kneel Mode" of the operations chart.

NOTE: The double check valves provide air to the bellows from either the normal LH leveling valve supply or from the R-12 relay valve's supply.

Rise Function (Effective With 48920)

When the driver's switch is repositioned to "RISE", solenoid valve (Sol-1) is energized fully and opens port 2 to port 3. This allows wet tank air to pressurize control port of R-12. High pressure supply air from the wet tank is then delivered to the air springs through the double check valves for fast recovery. As the bellows are repressurized, pressure switch (PS-2) senses cut-off pressure through the LH bellows. When PS-2 senses 50 psi, the solenoid valve (Sol-2) is closed and solenoid valve (Sol-1) is opened to allow the air springs to fill to the normal ride height. Refer to the "Rise Mode" of the operations chart.

NOTE: Wet tank delivery air is applied to the bellows at approximately the same pressure as the control air applied.

REAR-RISE SYSTEM

Normal Operation

During normal operation the LH/RH leveling valve supply air (at approximately 80 to 95 psi) flows through double check valves to each of the rear air spring bellows. The normally closed solenoid valve is de-energized with R-12 relay control line open to exhaust (port 1). The rear rise feature's air supply is provided through the rear rise reservoir tank and filled via the coach air system's rear junction block (Figure 10).

Rise Function

Positioning the switch to "RISE" (upper position) will automatically engage the speed switch control over electrical components of the rear-rise feature. While in this mode, the Skinner solenoid valve is electrically energized when coach speed falls below 15 mph and de-energized when speed rises above 20 mph.

NOTE: Prior to 1997 production this system was manually operated through the actuation of the rear-rise switch.

When the speed switch does fall below 15 mph, the control port of the R-12 is pressurized with 100 psi air provided by reducer valve and routed through the Skinner solenoid valve (port 2 & 3). This pressurization of the control port opens the R-12 supply ports to delivery. The higher pressure air from rear rise tank overcoming the double check, blocks normal leveling valve supply and additionally pressurizes the bellows.

NOTE: Rear rise tank delivery air is applied to the bellows at approximately the same pressure as the control air applied. Additional supply air is also provided by other service reservoirs in the coach air system.

CAUTION

It is important to note that the trailing axle's override switch will also override the automatic speed switch control over this Rear Rise feature. The tag override switch will keep coach raised, if in RISE mode when override is actuated. If it becomes necessary to disable the self-steering function by engaging the "TAG LOCKED" switch, first position the Rear-Rise switch to "LOWER" and allow coach to attain normal ride height.

It is not intended or is it recommended to continually operate the coach for extended periods with this feature in the RISE mode. Always reposition this feature's switch to lower suspension system to its normal ride height before performing any service or inspection procedures on the rear suspension.

Lower Function

When the speed switch does rise above 20 mph, the solenoid valve is de-energized. This exhausts the pressurized control line through port1 and out to a safe area of the engine compartment. The R-12 valve's delivery ports are closed to reservoir supply, and exhausts the bellows down to a differential pressure. Air pressure from the rear leveling supply then overcomes the double check and allows normal leveling operation to continue.

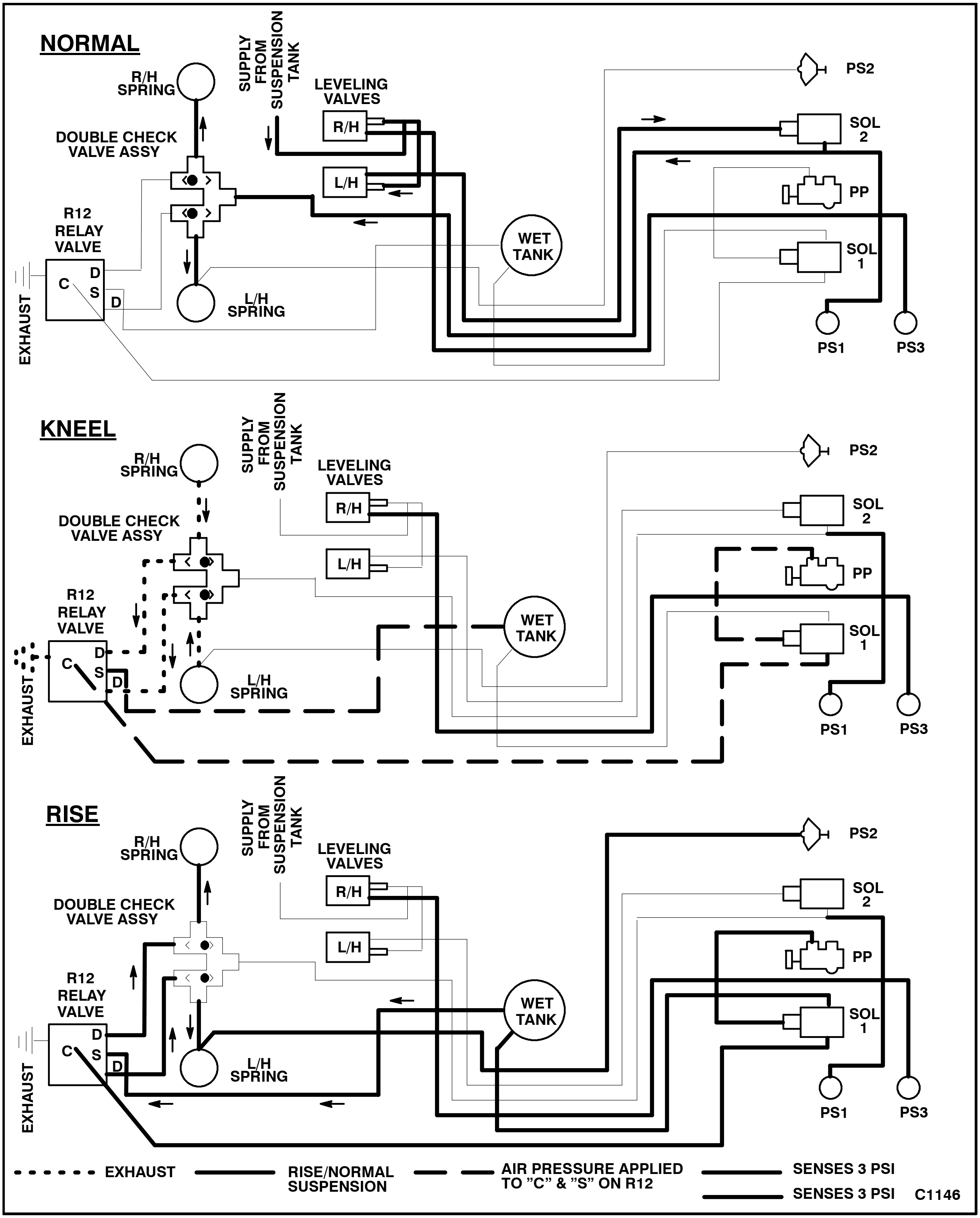

NORMAL
KNEEL
RISE
R/H SPRING
L/H SPRING
SUPPLY FROM SUSPENSION TANK
LEVELING VALVES
R/H
L/H
DOUBLE CHECK VALVE ASSY
R12 RELAY VALVE
C
D
S
D
EXHAUST
WET TANK
PS2
SOL 2
PP
SOL 1
PS1
PS3
EXHAUST
RISE/NORMAL SUSPENSION
AIR PRESSURE APPLIED TO "C" & "S" ON R12
SENSES 3 PSI
SENSES 3 PSI
C1146

Figure 9. Kneeling System: Effective With Unit 48920

NOTE: Prior to 1997 production, the rear rise switch must be manually repositioned to “LOWER” before the coach suspension will exhaust and lower.

PRESSURE PROTECTION SYSTEM

The pressure protection valve controls and isolates the supply air to the suspension/accessory air systems (Figure 11). Additional pressure protection valves are also incorporated into suspension system features such as the kneeling system and rear rise system.

NOTE: The main pressure protection valve located in the central heating compartment was changed. The old valve was set to close at 65 psi and open at 75-80 psi Effective with 48314, the valve is set to close at 80 psi and open at 95 psi.

As air enters the supply port it is stopped by the closed inlet valve. When the air pressure overcomes the pressure setting of the spring above the piston, the piston moves upward. The inlet valve opens and allows air to pass out the delivery port. When air pressure below the piston is reduced to a lesser force than that of the spring above, the piston moves down and closes the inlet valve.

The pressure setting is determined by adjustable spring force which is controlled by the cap. Turning the cap clockwise raises the pressure setting, while turning the cap counterclockwise lowers the pressure setting. The locknut must be tightened after each adjustment.

MAINTENANCE

LEVELING VALVE

Ride Height Adjustment

The correct coach body-to-axle clearance which should be maintained at both front and rear axle is 11 inches (27.9 cm). This dimension is measured from the top surface of bottom air spring support plate to the bottom surface of the top support plate (Figures 12 and 13).

It should not be necessary to make an adjustment under normal service conditions. However, if an adjustment is necessary, it can be made by changing the position of the over-travel lever by relocating the link’s fixed attachment point.

WARNING

Avoid accessing suspension components from outside coach wheel well areas. Unintentional actuation of the height control valves with fully inflated air springs could result in serious injury. Always block the coach body adequately during any inspections and/or repairs in these areas.

1. Fill coach air system completely (above 100 psi).
2. Place battery disconnect switch “Off”.
3. Locate the suspension system height control valve responsible for condition.
4. Unfasten link from the front or rear axle attachment bracket.
5. Move the fixed point up or down and reattach link.

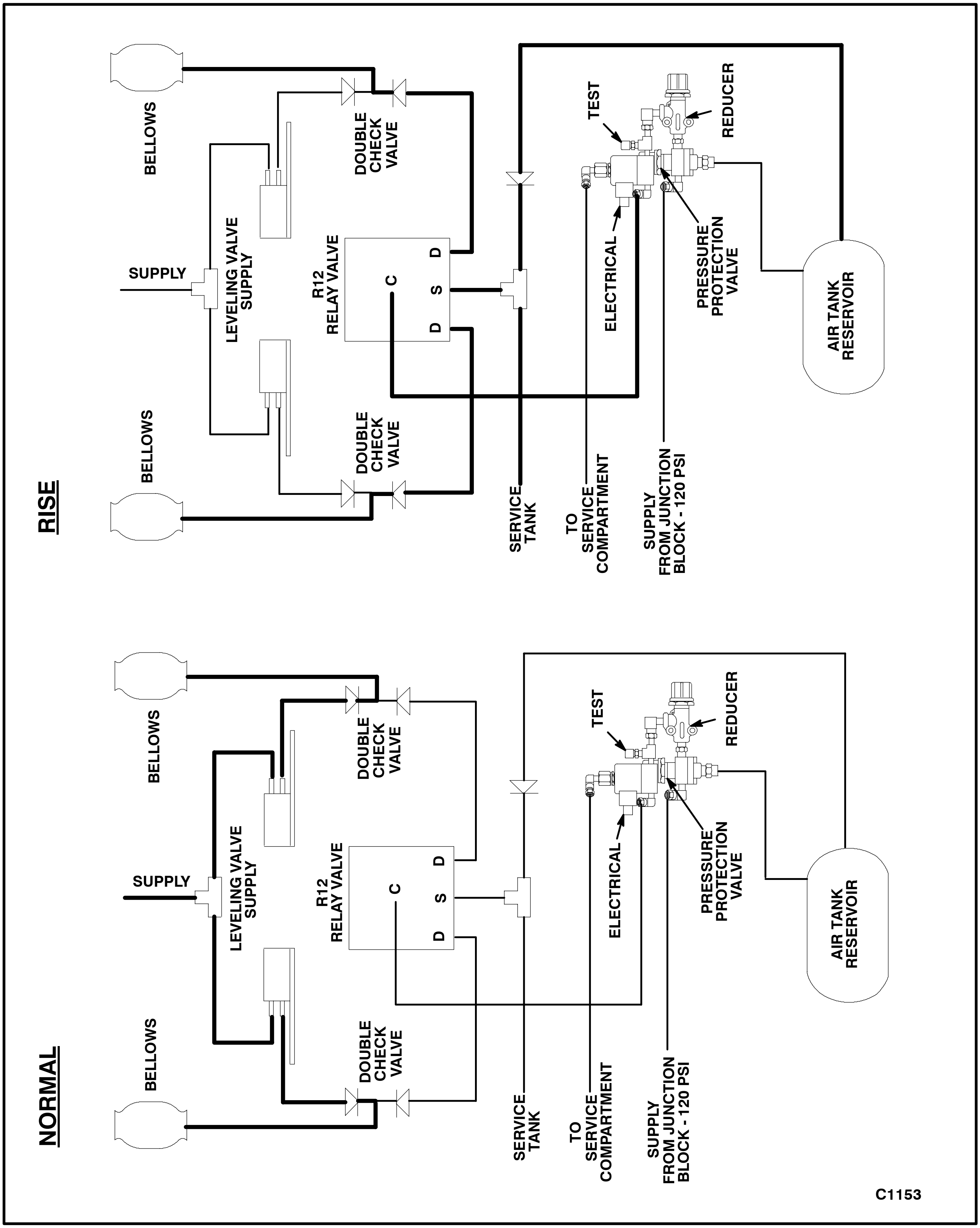
NOTE: Minor adjustments of 1/2” or less can be made by loosening locknut attaching metal over-travel lever to plastic pivot and shifting lever up or down. The link or lever should be moved up to raise the ride-height level or down to lower it. Always make these adjustments on the “filling cycle”. If coach height is too high, release sufficient air to below clearance dimension specified and then readjust to correct dimension. Check that air pressure is above 100 psi (690 kPa) and raise coach to the specified height.

Valve Adapter and Screen Replacement

Coach leaning or fall down from proper ride height levels could indicate leveling valve screen blockage and/or adapter thread leakage. Screen blockage and adapter damage can be corrected while valve is still mounted to coach with the following procedure.

NOTE: Check all suspension circuit inline filters and line connections to and from leveling valve for leakage or blockage before removing or repairing valve.

1. Place battery disconnect switch “Off”.
2. Locate the suspension system height control valve responsible for condition.
3. Support chassis by placing blocks under body at joist bumper points.
4. Open drain cock in air filter and vent all air from leveling system. Completely exhaust all air by loosening inlet and outlet line at leveling valve.
5. Disconnect the inlet and outlet air lines and remove the adapter assemblies and O-ring seals.
6. Remove the two small filter screens located behind the outlet adapter (Figure 14).
7. Clean inlet and outlet with solvent and blow dry with compressed air.
8. Replace the two small screens and install a new adapters with O-rings.
9. Reconnect air line and charge the air system
10. Remove chassis blocking and test system.


RISE
BELLOWS
DOUBLE CHECK VALVE
LEVELING VALVE SUPPLY
SUPPLY
R12 RELAY VALVE
C
S
D
D
BELLOWS
DOUBLE CHECK VALVE
TEST
REDUCER
ELECTRICAL
PRESSURE PROTECTION VALVE
AIR TANK RESERVOIR
SERVICE TANK
TO SERVICE COMPARTMENT
SUPPLY FROM JUNCTION BLOCK - 120 PSI
NORMAL
BELLOWS
DOUBLE CHECK VALVE
LEVELING VALVE SUPPLY
SUPPLY
R12 RELAY VALVE
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DOUBLE CHECK VALVE
TEST
REDUCER
ELECTRICAL
PRESSURE PROTECTION VALVE
AIR TANK RESERVOIR
SERVICE TANK
TO SERVICE COMPARTMENT
SUPPLY FROM JUNCTION BLOCK - 120 PSI
C1153

Figure 10. Hi-Rise System: Effective With Unit 48314

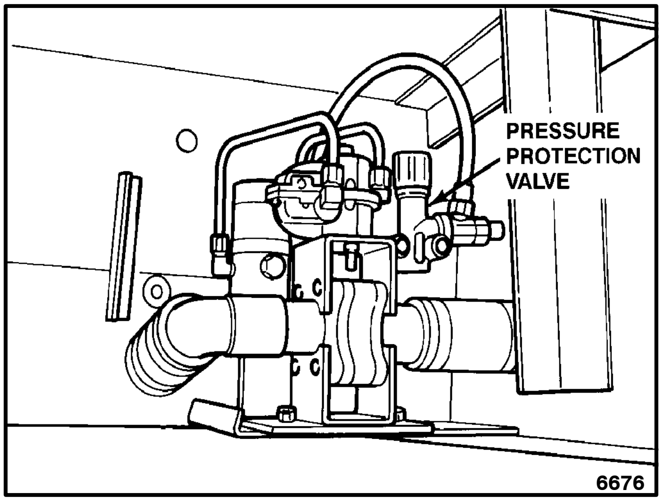


Figure 11. Pressure Protection Valve

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Support coach by placing blocks under joist bumper points.

3. Open drain cock in air filter and vent all air from system.

4. Disconnect over-travel lever from link and pull down to exhaust remaining air from air springs.

5. Disconnect both lines from control valve and cover the ends with tape to prevent contamination.

6. Detach height control valve from mounting bracket.

Replacement is the reverse of removal. After assembly, check for leakage using soap and water solution.

Leakage Test

The following procedure should be performed after the valve assembly is removed from vehicle.

1. Clean the exterior of the valve assembly.

2. Connect air pressure line to air valve inlet port, then open the air pressure 70-100 psi (483-690 kPa).

3. Dip the valve assembly in a container of water and watch for air bubbles when the over-travel lever is in the center position. No air should escape from any point of the valve assembly.

4. If bubbles appear from the bellows port, this is an indication that the air inlet valve is defective and that the leveling valve should be replaced.

5. Remove the air pressure line from the air inlet port and connect it to the bellows port. If bubbles appear at the air inlet check valve port, this is an indication that check valve is defective and that the leveling valve should be replaced.

6. If bubbles appear at the exhaust port, it is an indication that the exhaust valve is defective and that the leveling valve should be replaced.

7. If bubbles appear around edge of the valve cover plate, the cover plate gasket should be replaced.

8. If no leaks are found, remove the valve assembly from the water and blow out all passages.

Installation

1. Reinstall leveling valves in reverse order of “Removal” procedure and torque mounting fasteners to 15 ft-lbs.

UNLOADING VALVES (MANUAL)

Every 50,000 miles (80,000 km) or 1,500 operating hours the unloading valves should have an “Operational and Leakage Test“ performed (Figure 15).

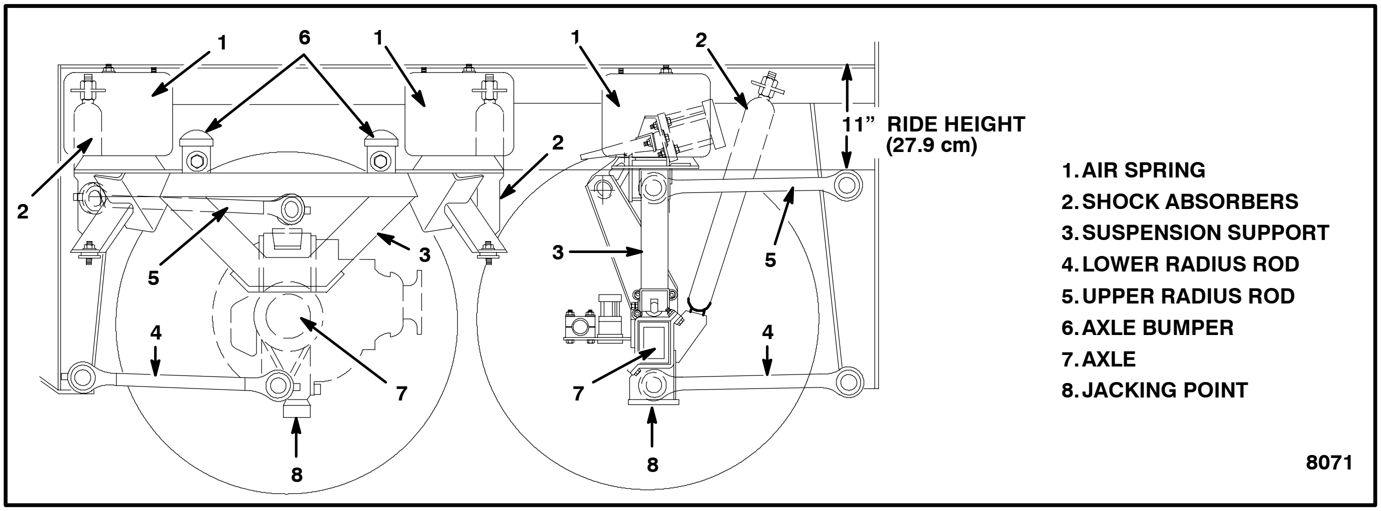


Figure 12. Rear Suspension

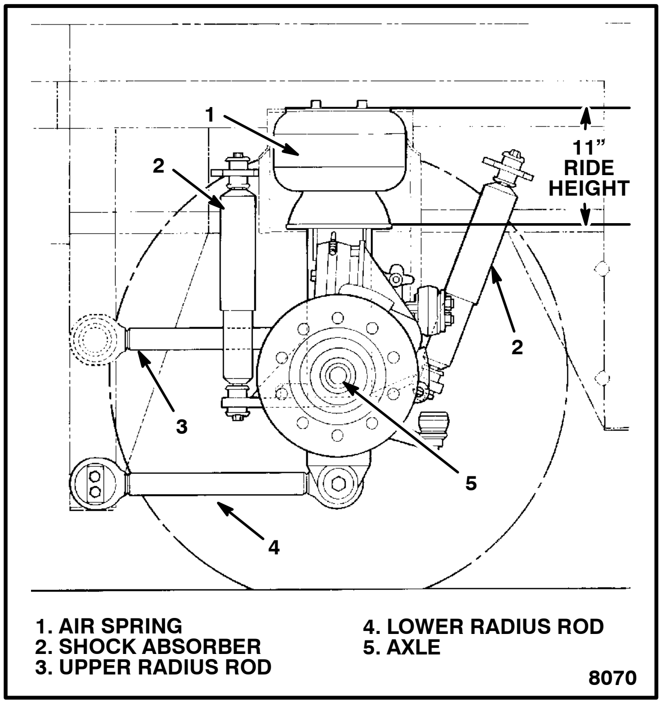


Figure 13. Front Suspension

Operating Test

With air pressure in the trailing suspension system, operate the valves to dump and then refill the suspension bellows. Also, check the function of the low tag bellows warning light switch.

Leakage Test

With the valves in the fill position, apply soap solution to them. Leakage at the exhaust port or at the valve stem should not exceed a one inch bubble in five seconds.

NOTE: If excessive leakage is detected while being tested, remove and replace the valve.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and disconnect all air lines and fittings, and remove the wire harnesses from the low air warning switches.
3. Unfasten the valve handle hex nut and remove.
4. Unfasten the valve mounting screws and remove valve from bracket.

Installation

1. Reinstall switch in reverse order of “Removal” procedure and torque mounting fasteners to 20 ft-lbs.

UNLOADING VALVES (ELECTRIC)

Every 100,000 miles (160,900 km) or each 3600 operating hours the Skinner solenoid valves should be disassembled, cleaned and inspected. The plunger, spring, piston and seals should be checked and replaced if necessary.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and disconnect all air lines and fittings, and remove the wire harnesses from the solenoid assemblies.
3. Unfasten the regulator valve mounting screws and remove regulator/solenoid valve assembly from panel.
4. Remove solenoid valves from regulator plumbing.

Disassembly

1. Remove the sleeve adapter, adapter seal, housing nut, nameplate and housing.
2. Remove coil assembly from housing if necessary.
3. With special skinner wrench nut, remove sleeve from body.

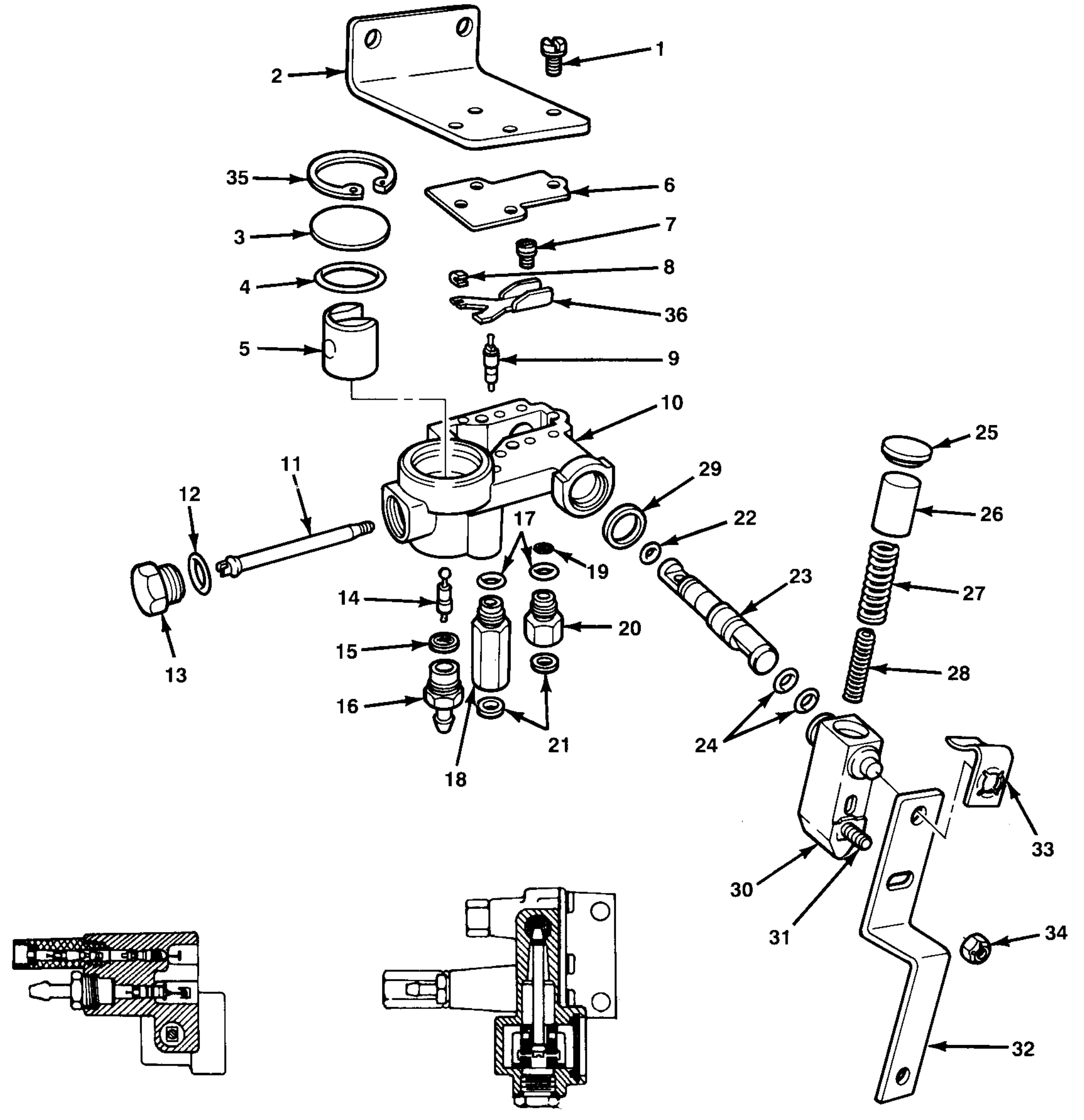
⚠ CAUTION ⚠

Never use a wrench on the sleeve itself. Damage to the sleeve may occur.

4. Remove spring, plunger and flanged seal from body.

NOTE: Wash plunger assembly, seals and o-rings in mild soap and water solution only.

5. Apply mineral oil to the flanged seal, and reinstall into valve body.
6. install plunger and spring in sleeve, and tighten sleeve into body with wrench nut to 135 in.lb. (15.4 N•m).
7. Install coil into housing, and assembly housing components in reverse order tightening nut to 35 in.lb. (4.1 N•m).
8. Reinstall onto module assembly.
9. Connect air lines and electrical harness.
10. Turn battery switch on, start engine, and test valve’s operation.



SECTION THROUGH VALVE

SECTION THROUGH DELAY PISTON AND PIN

1. Cover Screw & Lock Washer
2. Cover & Bracket
3. Delay Cover
4. Delay Cover O-Ring
5. Delay Piston
6. Cover Gasket
7. Valve Lever Screw
8. Valve Stem Lock Clip
9. Intake Valve Core
10. Valve Body
11. Piston Pin
12. Plug O-Ring
13. Delay Plug
14. Exhaust Valve Core
15. Exhaust Screen
16. Exhaust Fitting
17. Adapter O-Ring
18. Inlet Adapter and Check Valve Assembly
19. Outlet Adapter Screen
20. Outlet Adapter
21. Airline Fitting Gasket
22. Shaft O-Ring (Medium)
23. Overtravel Control Shaft
24. Shaft O-Ring (Large)
25. Overtravel Body Plug
26. Overtravel Piston
27. Overtravel Spring (Large)
28. Overtravel Spring (Small)
29. Overtravel Control Body Seal
30. Overtravel Control Body
31. Overtravel Lever Stud
32. Overtravel Lever
33. Plug Retainer
34. Lever Stud Nut
35. Delay Cover Retainer
36. Intake & Exhaust Valve Lever

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Figure 14. Height Control Valve Component Parts

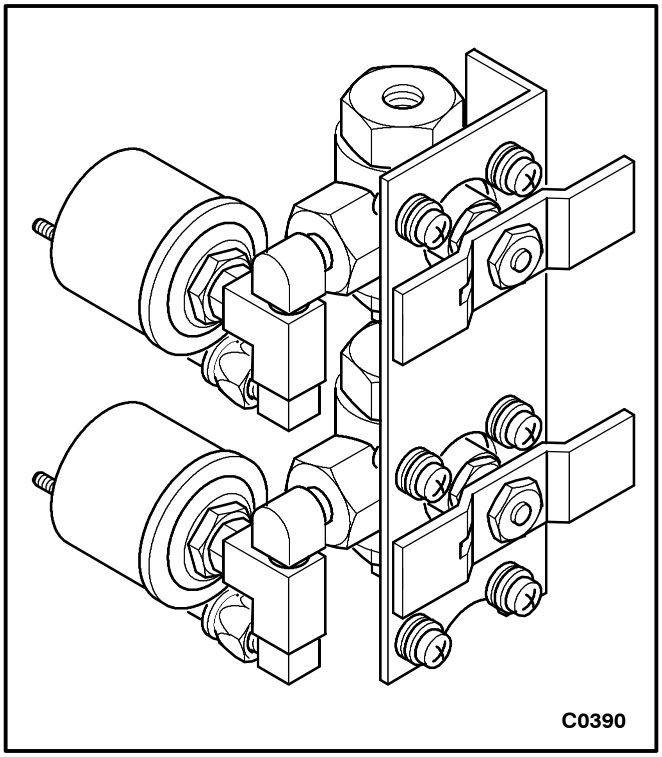

Figure 15. Tag Axle Unloading Valve

LIFTING & UNLOADING CONTROL VALVES

NOTE: There are no periodic maintenance requirements for the Parker or Norgren control valves other than lubrication.

Every 50,000 miles (80,000 km) or 1,500 operating hours the control valves should be lubricated. Lubricate the spool and valve bore surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) applied through the air lines.

Removal

1. Turn Battery switch to “Off”.
2. Unfasten retaining screw and disconnect the electrical harness connector housing from valve solenoid assembly.
3. Disconnect and label all air lines from valve ports.
4. Unfasten mounting capscrews and remove valve from panel or enclosure.

Installation

1. Reinstall valve in reverse order of “Removal” procedure and torque mounting fasteners to 20 ft-lbs.

QUICK RECOVERY VALVE

Every 100,000 miles (160,900 km) or each 3600 operating hours the Skinner solenoid valve should be disassembled, cleaned and inspected.

NOTE: Valve need not be removed from the line to be disassembled, cleaned and inspected or for solenoid replacement.

Solenoid Replacement

1. Place battery disconnect switch “Off”.
2. Follow steps 5 and 6 of the disassembly procedure.
3. Install new coil and follow steps 2 of the assembly procedure.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Disconnect electrical harness from coil assembly.
3. Disconnect the quick recovery valve, pressure switch and plumbing assembly from the suspension junction block and leveling valve air lines.
4. Remove the quick recovery valve from the plumbing assembly.

Disassembly

1. Unfasten the hex nut on top of the coil assembly.
2. Remove the coil and wave washer from valve.
3. Slide the Skinner wrench nut (P/N U99-011) over the sleeve tube, mate the nut to the sleeve flange and turn wrench to unfasten and remove sleeve assembly.
4. Remove the plunger, return spring and O-ring flange seal.
5. Unfasten top cover screws and gently lift cover off.

NOTE: Take care not to damage cover or body of valve.

6. Remove the diaphragm, diaphragm return spring and O-ring cover and body seals.

Assembly

1. Reassembly valve in reverse order of the disassembly procedure.
2. Install the hex nut on top of the coil assembly and torque to 43-53 in-lbs.

Installation

1. Install valve assembly in reverse order of the removal procedure.

CASTER & LOCKING CONTROL VALVES

NOTE: There are no periodic maintenance requirements for the Norgren control valves other than lubrication.

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Every 50,000 miles (80,000 km) or 1,500 operating hours the control valves should be lubricated (Figure 16). Lubricate the spool and valve bore surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) applied through the air lines.

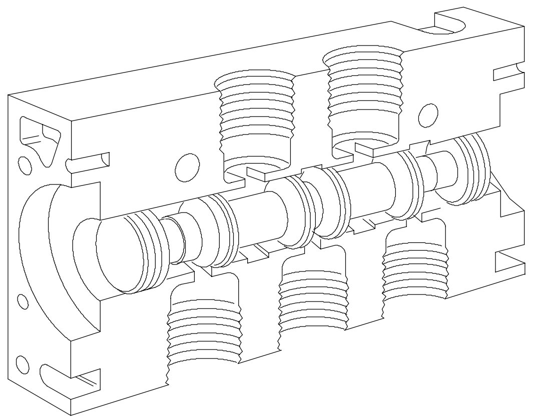


Figure 16. Caster Control Valve

Lubrication

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Disconnect air lines from the manifold and valve.
3. Apply two drops of lubricant to each port and reconnect.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and disconnect all air lines and fittings, and remove the wire harnesses from the solenoid assembly.
3. Unfasten the valve mounting screws and remove the valve from the manifold.

Disassembly

1. Unfasten the solenoid mounting screws and remove the solenoid assembly, seal and piston.
2. Unfasten the return cap mounting screws and remove the cap body, seal, spring and spacer.
3. Push spool out of valve, and remove the O-ring seals.

Assembly

1. Reassemble valve in reverse order of “Disassembly” procedure and torque mounting fasteners to 12 ft-lbs.

Installation

1. Reinstall valve in reverse order of “Removal” procedure and torque mounting fasteners to 20 ft-lbs.

AIR CYLINDER (CASTERING)

Every 50,000 miles (80,000 km) or 1,500 operating hours the air cylinder should be lubricated. Lubricate the bore surface with lubrication specification S-6 (Light Oil 10W) applied through the air lines.

Removal

NOTE: Block or clamp the latching horn of the axle in place during cylinder removal.

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and disconnect all air lines and fittings, and remove the wire harness from the reed switches.
3. Unfasten the cylinder rod end from the clevis assembly.
4. Unfasten the mounting screws and remove the cylinder from the mount plate.

Installation

1. Reinstall cylinder in reverse order of “Removal” procedure and torque mounting fasteners to 25 ft-lbs (33 N·m).

AIR CYLINDER (LOCKING)

Every 50,000 miles (80,000 km) or 1,500 operating hours the air cylinder should be lubricated. Lubricate the bore surface with lubrication specification S-6 (Light Oil 10W) applied through the air lines.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and disconnect all air lines and fittings, and remove the wire harness from the reed switches.
3. Unfasten the mounting screws and remove the cylinder and index pin from the mount block.

Installation

1. Reinstall cylinder in reverse order of “Removal” procedure and torque mounting fasteners to 25 ft-lbs (33 N·m).

EXHAUST CONTROL VALVE (KNEELING)

Every 100,000 miles (160,900 km) or each 3600 operating hours the Humphrey dual-solenoid valve should be disassembled, cleaned and inspected.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Open control box and close both isolating ball valves.
3. Turn manual level control valve to exhaust. Loosen the air line connectors on the supply and delivery ports of the exhaust control valve and allow any pressure to vent.

4. Disconnect electrical harnesses from coil assemblies.

5. Unfasten the connector fittings and remove air lines from valve ports.

6. Unfasten valve mountings and remove it from the box.

Installation

1. Reinstall valve in reverse order of “Removal” procedure and torque mounting fasteners to 25 ft-lbs (33 N·m).

FAST RECOVERY VALVE (KNEELING)

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.

2. Open control box and close both isolating ball valves.

3. Turn manual level control valve to exhaust and disconnect the three lines to the manual level valve.

4. Disconnect electrical harness from coil assembly.

5. Unfasten valve mounting screws from bracket.

6. Disconnect the fast recovery valve, manual level control valve and piping tee from the ball and check valve assembly.

7. Unfasten the fast recovery valve from the manual level valve.

Installation

1. Reinstall valve in reverse order of “Removal” procedure and torque mounting fasteners to 15 ft-lbs (20 N·m).

RELAY VALVE R-12

Every 25,000 miles (40,000 km) or 750 operating hours, the relay valve should have an “Operational and Leakage Test” performed (Figure 17).⌧

Operational and Leakage Test

1. Block the wheels, charge air brake system and adjust the brakes.

2. Make several brake applications and check for prompt application and release of brakes at each wheel.

3. Check for inlet valve and O-ring leakage by coating the exhaust port and area around the retaining ring with soap solution. A one inch bubble in three seconds is permitted.

NOTE: Make this check on the service R-12 with the service brakes released.

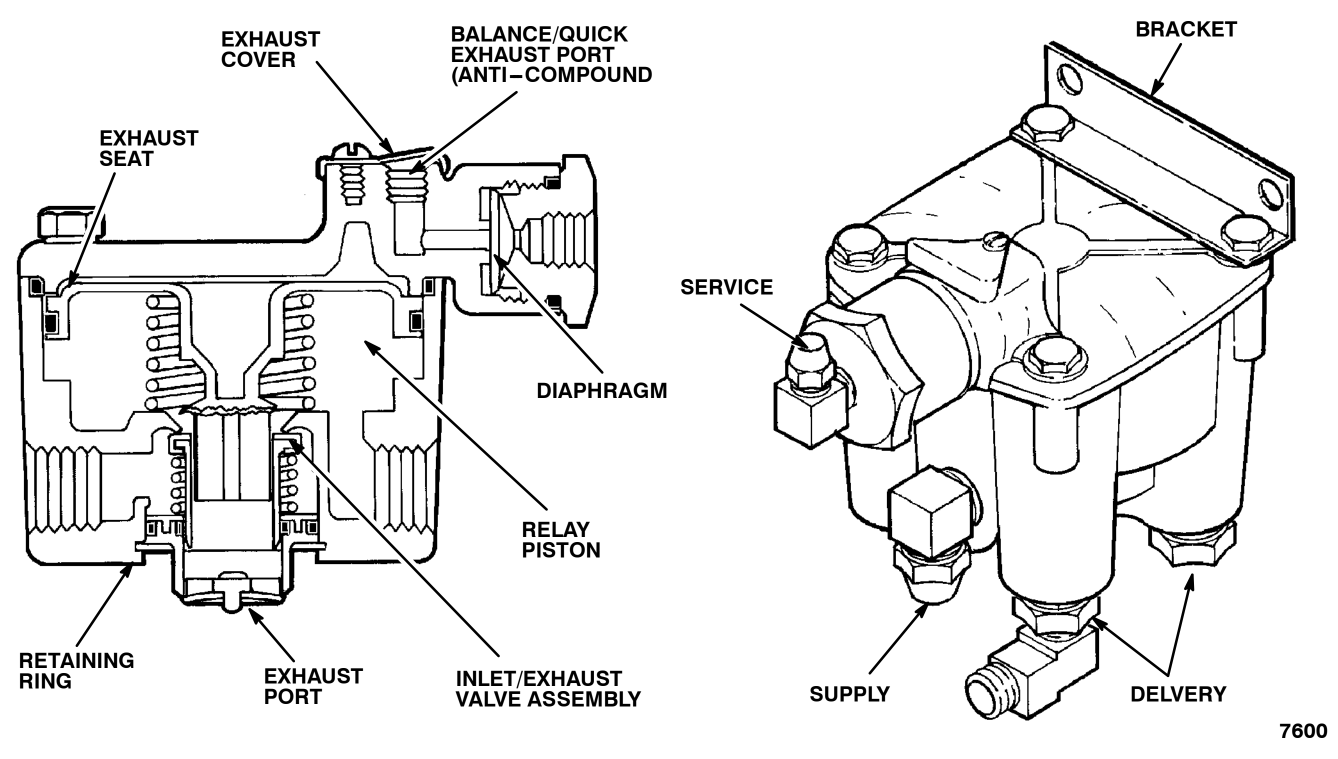

EXHAUST COVER
BALANCE/QUICK EXHAUST PORT (ANTI−COMPOUND
EXHAUST SEAT
DIAPHRAGM
RELAY PISTON
RETAINING RING
EXHAUST PORT
INLET/EXHAUST VALVE ASSEMBLY
BRACKET
SERVICE
SUPPLY
DELIVERY
7600

Figure 17. Service R-12 Relay Valve

4. Check for exhaust valve leakage by coating the exhaust port and area around the retaining ring with soap solution. A one inch bubble in three seconds is permitted.

NOTE: Make this check on the service R-12 with brakes applied.

5. Apply soap solution around the valve where the cover joins the body to check for seal ring leakage. No leakage is permitted.

If the relay valve does not function properly, or if leakage is excessive, disassembled and repair.

Every 100,000 miles (161,000 km) or 3,000 operating hours, disassemble, clean and inspect all parts. Install new rubber parts and replace any worn or damaged parts.

Removal

1. Place battery disconnect switch "Off". Block vehicle and vent the entire air system.
2. Tag and remove all air lines from the relay valve.

NOTE: The balance port is not used with the D series dual circuit brake system, and, therefore, remains plugged.

3. Unfasten and remove the relay valve from the coach.

Disassembly

NOTE: Prior to disassembly, match-mark the location of the mounting bracket to the cover and the cover to the body.

1. Remove the four capscrews and lockwashers securing the cover to the body.
2. Remove the cover, sealing ring, and mounting bracket.
3. Remove the piston and O-ring from the body.
4. While depressing the exhaust cover, remove the retaining ring and slowly relax the spring beneath the exhaust cover.
5. Remove the exhaust cover assembly and O-rings.
6. Remove the inlet/exhaust valve return spring from the body.
7. Remove the inlet/exhaust valve from the body.
8. Remove the valve retainer from the inlet/exhaust valve.
9. Remove the phillips head screw and exhaust cover from the body cover.
10. Remove the service port capnut and O-ring.
11. Remove the diaphragm from the cover.

Cleaning and Inspection

1. Wash all parts in mineral spirits, and dry all rubber parts.

NOTE: When rebuilding, all springs and rubber parts should be replaced.

2. Inspect all parts for signs of wear and/or deterioration. Inspect springs for cracks, distortion or corrosion.
3. Inspect inlet seat and exhaust seat for nicks and burrs and replace as necessary. All rubber parts and any part showing signs of wear or deterioration should be replaced.

Assembly

Lubricate all O-rings, O-ring bores and any sliding surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) prior to assembly.

1. Install large O-ring on piston.
2. Install inner and outer O-rings in the exhaust cover assembly.
3. Install the sealing ring on the cover.
4. Install piston in body, taking care not to damage the O-ring.
5. Aligning the match-marks made during disassembly, install the cover on the valve body and the mounting bracket on the cover.
6. Secure the mounting bracket and cover to the body using the four capscrews and lockwashers. Tighten to 80-120 in-lbs. (9-14 N·m) torque.
7. Install the valve retainer on the inlet/exhaust valve and install in the body.
8. Install the inlet/exhaust valve return spring in the body.
9. Install the exhaust cover assembly in the body taking care not to damage the O-ring.
10. While depressing the exhaust cover, install the retaining ring. Make certain the retainer is completely seated in its groove in the body.
11. Install the service port cap nut O-ring on the cap nut.
12. Install the diaphragm in the cover making sure it is positioned between the guide ribs in the cover.
13. Install the port cap nut and torque to 150 in-lbs.
14. Install the exhaust port cover with the #10-24 phillips head screw. Torque to 15-25 in-lbs.
15. Test the valve as outlined in the Service Check section before returning the valve to service.

Installation

1. Clean air lines and connect them to valve.

2. Install valve and tighten mounting bolts to 20-25 ft-lbs (27-34 N·m) torque.

3. Test valve as outlined in “Operational and Leakage Tests”.

KNEELING SYSTEM

Adjustments (Effective With 48920)

The coach kneeling feature should be periodically adjusted to assure proper operation. The adjustment interval should be based on individual usage of the system and its operational characteristics.

1. Place the coach main battery disconnect switch to “OFF”.

2. Disconnect the leveling link from the ride height (L/H) leveling valve. Pulling down on the leveling valve arm, drain coach bellows to 10.00”.

3. Disconnect the gray airline from the quick recovery (R/H) leveling valve. At 10.00” ride height there should be no air being supplied from this leveling valve.

> **NOTE:** This valve does not supply air directly to the bellows, but only acts as a pressure switch to tell PS3 when the coach has hit 10.00” ride height on quick recovery.

4. If air is being supplied, loosen the nut at the R/H leveling valve arm and adjust the leveling valve to a 10.00” ride height.

> **NOTE:** If there is not enough adjustment at the leveling valve, the 12K-3-7 bracket mounting the leveling valves has slotted holes and the leveling valve assemblies can be slid up or down as required. If leveling valves are moved on the 12K-3-7 bracket assembly, the normal ride height (L/H) valve will need to be readjusted.

5. The pressure protection valve in the kneeling box is set to close at 20 psi preventing the bellows from completely sitting on the suspension bumpers. There is a test fitting on this valve where pressure can be checked with the coach in its kneel position.

6. The Williams regulator is set at 30 psi to activate the kneeling light only. This valve no longer acts as a quick recovery valve. A test fitting is also supplied on the valve and this can be checked with the coach going down to kneel or in the recovery mode.

IN SUMMARY:

A. R/H leveling valve acts as the quick recovery shut off. When the coach hits 10.00” ride height, the normal leveling valve will take over. Normal ride height is 11.00”. There needs to be a 1.00” separation maintained between the two leveling valves.

> **NOTE:** Unlike the normal leveling valves, the R/H leveling valve has no delay feature.

B. Pressure protection valve is set at 20 psi in the kneel mode.

C. Williams electric regulator is only for kneeling light activation. When the coach kneel switch is activated, the customer will notice the coach jumps up slightly. This is because Skinner valve (Sol-2) has reversed polarity and is blocking normal leveling valve air to the two-way check valves while (Sol-1) valve has briefly supplied high pressure air to the R-12 valve, setting the check valves. This allows the bellows to exhaust out the R-12 valve’s 1/2” airlines.

D. When the coach is coming back up, (Sol-1) will again trigger the R-12 valve control port allowing air directly from the wet tank to fill the bellows. When the coach bellows hits 10.00”, the R/H leveling valve will stop supplying air to the PS-3 switch. (Sol-1) is de-energized and stops supplying air to the R-12 valve. (Sol-2) reverses its polarity again, resetting the double check valves to get its air supply from the normal leveling valve.

PRESSURE PROTECTION VALVE

Every 25,000 miles (40,000 km), or 750 operating hours Perform the operational and leakage tests.

Leakage Test

1. Block the wheels and fully charge air system before turning engine off.

2. Apply soap solution to the valve cap. A one inch bubble in three seconds is permitted.

3. Drain air pressure from the delivery side of valve, disconnect the delivery ports line and apply soap solution to the delivery port. A one inch bubble in five seconds is permitted.

If the leakage is excessive, around the cap and delivery port, repair or replace the assembly.

Operational Test

1. Install a pressure gauge and drain valve on the supply and delivery sides of the valve.

2. Build system air pressure and turn engine off.

3. While watching the gauges on both sides, slowly exhaust air from the delivery side of valve until valve closing pressure is reached.

> **NOTE:** Both sides should show pressure loss until the the closing pressure of the valve is reached. Closing pressures should be noted on valve. Opening pressures are 15-20 psi greater that closing pressure.

Every 100,000 miles (161,000 km), or 3600 operating hours disassemble, clean and inspect all parts. Replace all rubber parts, and any metal parts showing signs of wear or deterioration (Figure 18).

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Tag and remove all air lines from the valve.
3. Unfasten and remove the valve from the coach.

Disassembly

1. Loosen locknut from knob and unscrew adjust knob, then remove locknut.
2. Remove spring, piston, piston plug and inlet valve from body.
3. Remove inlet valve from stem, spring retainer and inlet valve spring.
4. Turn piston over and depress the inlet valve stem fully and remove the O-ring.
5. Clean and inspect all rubber parts and springs for wear.

Assembly

Lubricate all O-rings, O-ring bores and all sliding surface with lubrication specification S-25 (Silicon Fluid - DOW CORNING 200) prior to assembly.

1. Reinstall inlet valve stem into piston.
2. Install small O-ring on piston plug and install piston plug pressing snugly into piston body.
3. Install inlet valve spring, spring retainer and snap on the rubber inlet valve.
4. Install inlet valve spring, spring retainer and snap on the rubber inlet valve.
5. Install O-ring onto piston end and insert into body.
6. Replace spring and install adjust knob locknut.
7. Replace adjusting knob and readjust the valve before tightening locknut to knob.

Installation

1. Reinstall pressure protection valve in reverse order of the “Removal” procedure.

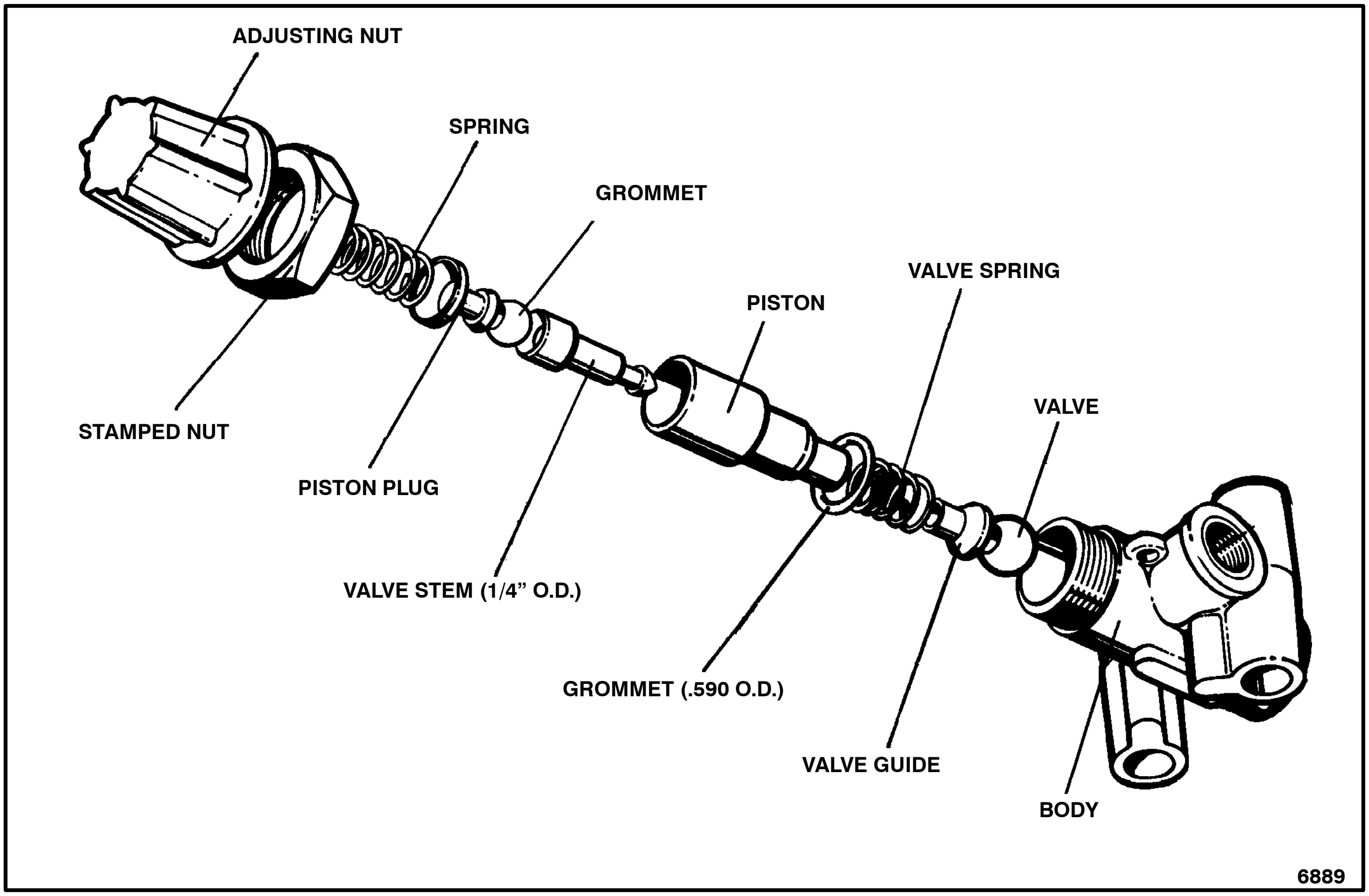


Figure 18. Pressure Protection Valve

SUSPENSION AIR FILTER

Every 50,000 miles (80,000 km) or 1,500 operating hours the filter should be disassembled, cleaned and inspected. The element and cover gasket should also be replaced (Figure 19).

CAUTION

Failure to service the air filters at regular intervals may affect the operation of other components (i.e., leveling control valves, retracting step control and main hot water valve).

NOTE: It is recommended that all of the filters be serviced at the beginning of winter to prevent freeze damage.

Removal

1. Place battery disconnect switch “Off”. Block vehicle and vent the entire air system.
2. Manually actuate the condensate/air drain.
3. Tag and disconnect all air lines and fittings.
4. Unfasten the filter mounting capscrews and lockwasher from bracket, and remove the filter.

Disassembly

1. Unfasten the two capscrews and separate the two body halves.
2. Remove the spring, filter element and gasket.
3. Clean and inspect the inside of filter body for excessive corrosion or blockage.

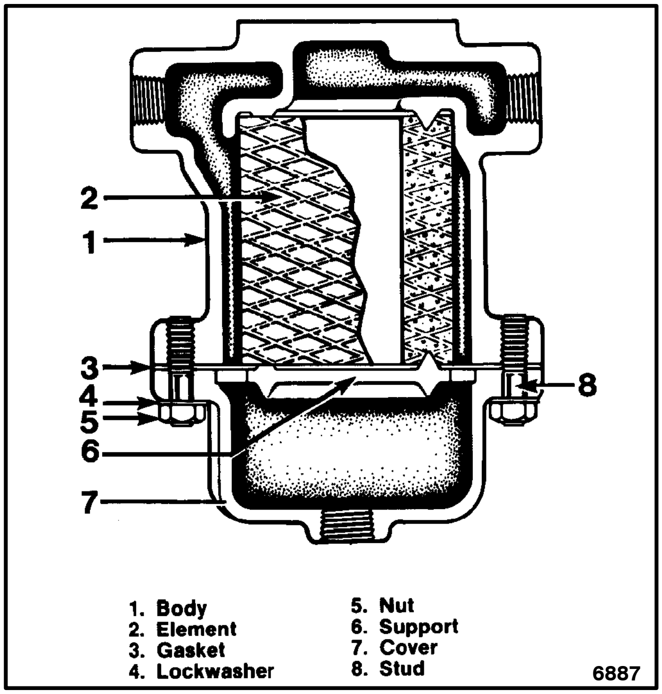


Figure 19. Type “E” Air Filter

Assembly

1. Install new element and gasket and reassemble valve in reverse order of their “Disassembly” procedure. Torque body capscrews to 20 ft-lbs.

Installation

1. Reinstall switch in reverse order of “Removal” procedure and torque mounting fasteners to 30 ft-lbs.

SPECIFICATIONS

HEIGHT CONTROL/LEVELING VALVES

Manufacturer	King Of The Road
Part Number (102D3 & 102DL3)	12C-6-1 Front
Part Number (102D3 & 102DL3)	12L-6-63 Kneeling RH Front
Part Number (102DL3)	12C-6-1 RH Rear
Part Number (102DL3)	12C-6-2 LH Rear
Part Number (102D3)	12K-6-11 RH Rear
Part Number (102D3)	12K-6-12 LH Rear

MANUAL UNLOADING & LEVEL CONTROL VALVES

Manufacturer	Watts
Part Number	4L-22-17

UNLOADING SOLENOID VALVES

Manufacturer	Skinner Valve Div. Honeywell Inc.
Part Number (3-Port Normally-Closed)	16B-10-56

LIFTING SOLENOID VALVES

Manufacturer	Norgren
Part Number (5-Port Air Piloted Normally-Open)	7L-8-587
Part Number (3-Port Air Piloted Normally-Closed)	7L-8-741

LIFTING & UNLOADING SOLENOID VALVES

Manufacturer	Parker
Part Number (3-Port 3-Way Inline)	4L-22-134

SELF-STEERING LOCKING & LATCHING SOLENOID CONTROL VALVES

Manufacturer	Norgren
Part Number (5-Port 4-Way 2-Position)	4L-22-55

KNEELING EXHAUST CONTROL DOUBLE CHECK VALVE

Manufacturer	Bendix
Part Number (3-Port)	4R-15-2

LIFTING & UNLOADING REGULATOR VALVE

Manufacturer	Williams
Part Number (Set @ 40 psi)	4L-22-148

KNEELING REGULATOR VALVE

Manufacturer	Williams
Part Number (Set @ 30 psi)	4R-19-134

AIR CYLINDERS

Manufacturer	Bimba
Part Number (Locking)	12L-4-164
Part Number (Latching)	12L-4-169

SELF-STEERING SPEED SWITCH

Manufacturer	Forrester
Part Number	7L-8-829

LOW AIR WARNING SWITCH

Manufacturer	Texas Instruments
Part Number	7L-8-885

SPECIFICATIONS (CONTD.)

KNEELING PRESSURE SWITCH

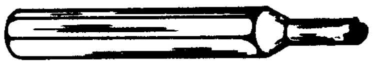
Manufacturer	Williams
Part Number (PS-1 & PS-3 Set at 3 psi)	8K-28-1
Part Number (Set at 30 psi)	4R-14-2

INTERIOR & EXTERIOR MOUNTED SWITCHES

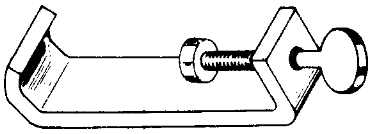
Manufacturer	Micro-Switch
Part Number (“TRAIL AXLE”)	7L-8-800 (Rocker)
Part Number (“KNEEL”)	7G-8-249 (Exterior Toggle)
Part Number (“KNEEL”)	7L-8-438 (Interior Rocker)
Part Number (“TAG LOCK”)	7L-8-1007 (Toggle)

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS.



20-25 Valve Replacement Tool — For Control Valve



20-36 Tool - Height Control Valve Overtravel Lever (Piston Compressor)

6897

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 13

TRANSMISSION

A1 - Manual Transmission - Fuller 5 Speed (Model T-11605-D & T-11605-F)
A2 - Manual Transmission - Fuller 7 Speed (Model T-14607-A & TX-14607-B)
A3 - Manual Transmission - Fuller 10 Speed
    (Model RTX-13710-B, RTLO-14610-A & RTAO-14710-B-AS)
A4 - Shift Controls
B1 - Automatic Transmission - Allison Mechanical 4 Speed (Model HT-740D)
B2 - Automatic Transmission - Allison ATEC 4 & 5 Speed
    (Model HT-741, HT-746 & HT-755)
B3 - Automatic Transmission - Allison WT 5 Speed
    (B-500, B-500R, HD-4060 & HD-4060R)
B4 - Electronic Control Systems (ATEC & World Transmission)

SECTION 13A1

MANUAL TRANSMISSION (5-SPEED)

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 13A1-1
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Operation 13A1-2
Maintenance 13A1-3
Service Tools 13A1-5
Torque Specifications 13A1-6
Specifications 13A1-6

GENERAL DESCRIPTION

Some D Series coaches may be equipped with the Fuller® Model T-11605-D or T-11605-F 5-speed manual transmission (Figure 1). These transmissions are designed with five forward speeds and one reverse. This series transmission is rated for engines up to 370 hp, and 1,150 ft-lbs torque (1559 N·m).

These transmissions feature heavy-duty cast steel housings, twin countershaft gear arrangements, fine pitch “multi-mesh” gearing, fork actuated sliding clutch gear shifting, remote shift control, integral clutch housing release mechanism and reverse/neutral function and interlock switches.

Transmissions are shifted via a shift linkage connecting the lever actuated master shift control to the transmission mounted remote slave shift control box. A standard three rail shift pattern is used for shifting function (Figure 2) See section 13D for more information on the SCR-1 master shift control and LRC remote shift control boxes and the shift linkage.

The optional Model T-11605-F “fuel saver” manual transmission is often utilized in conjunction with drive axles installations having 3.33 or 3.85 gear ratios. This combination provides for greater fuel economy. Gear ratios on the T-11605-F differ from the T-11605-D.

COMPONENTS

COUNTERSHAFTS

Twin countershaft design divides the rated torque equally between two shafts. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of gears.

MAINSHAFT

The mainshaft assembly features the floating gear principle. These gears, when not engaged, “float” between the countershaft gears, eliminating the need for gear sleeves and bushings.

> **NOTE:** Only the countershaft gears which mate with multi-mesh mainshaft gears have fine pitch gearing (i.e., first and reverse gears are of the coarse pitch conventional gearing type).

HOUSING

The clutch housing mounts to the engine, and the gear case and clutch housings bolt directly to each other. The gear case provides for oil sump, fill and drain plugs, remote shift control mounting and various bearing and inspection hand hole covers.

CLUTCH RELEASE MECHANISM

The clutch housing incorporates provisions for the pull-type clutch release bearing carrier, release yoke, shafts and adjustable actuating arm. The clutch control housing incorporates lube galleries for greasing the release bearing shafts. For more information regarding the release mechanism, see section 5.

SHIFT BAR HOUSING

The shift bar housing contains the shift forks that slide the clutch gears forward or backward to engage a specific gear. The LRC remote shift control is mounted to the top of the shift bar housing and actuates the shift forks.

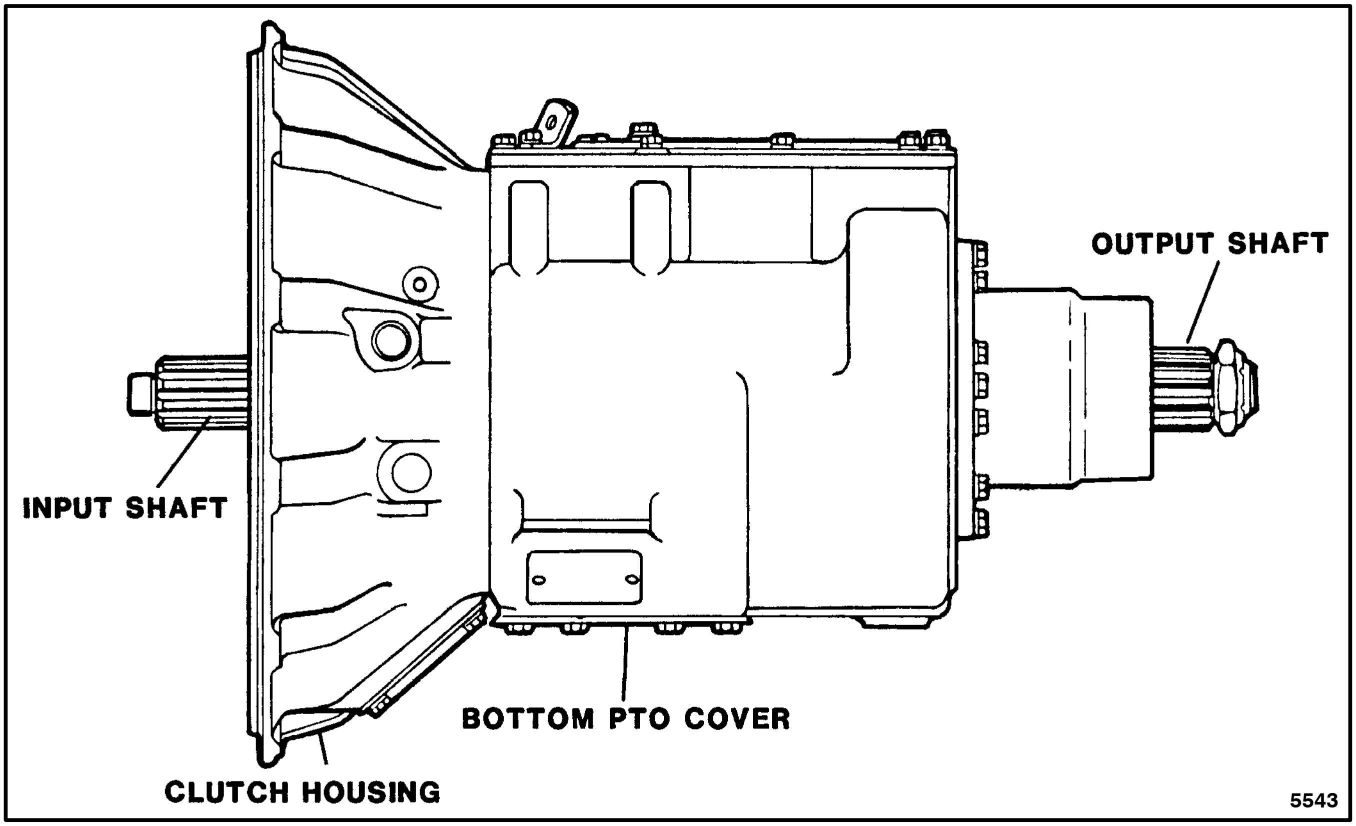


Figure 1. T-11605 Transmission

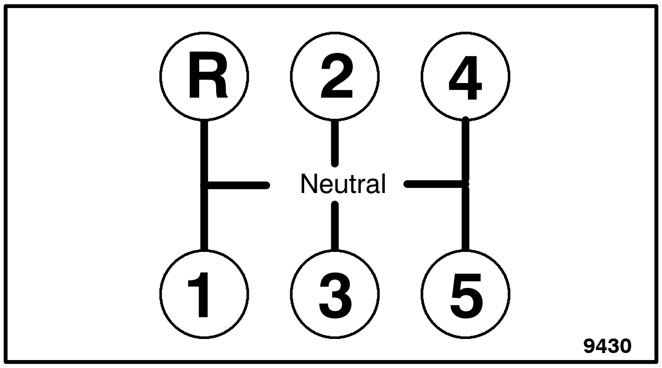


Figure 2. 5-Speed Shift Pattern

DIPSTICK & FILL TUBE

A dipstick and filler tube are installed into the transmissions for easy filling and checking of transmission lubricant. Access to the dipstick and filler tube is through the LH rear side service door.

NOTE: Effective with unit 47701 the dipstick and filler tube will no longer be installed. The fill tube hole will be plugged.

OPERATION

To convert the constant high-speed, high-torque, rotational energy of the engine into a variable speed, higher torque low-inertia rotation that can be used to move the coach, the transmission must be able to be shifted from one gear range to another. Gear shifts are accomplished through an arrangement of three fork actuated sliding clutch gears positioned along the mainshaft of the transmission.

Input shaft rotation is transmitted to twin countershafts either side of the mainshaft. The countershafts are fitted with gears that continuously rotate and rotate a mating gear on the mainshaft. Rotating mainshaft gears are not directly coupled to the mainshaft, therefore, shaft rotation is achieved only by engagement of the slide clutch gears.

Each sliding fork of the shift bar housing is attached to one of the sliding clutch gears. As a shift fork is indexed for a specific speed via the remote shift control, the clutch gear moves to engage the inner gear of the adjacent front or rear mainshaft floating gear. Engagement into the rotating mainshaft gear causes the slide gear to rotate and turn the mainshaft and output shaft. The selection and engagement of a specific gear thereby increases or decreases the output shaft speed of the transmission.

MAINTENANCE

PERIODIC INSPECTIONS

Every 5,000 miles (8,000 km) or 150 operating hours clean the exterior of the transmission and make the following inspections:

1. Check all transmission to engine mounting fasteners.
2. Remove filler plug or dipstick and check lube oil level. Check for any oil leaks.
3. Check for correct adjustment and operation of the shift linkage and clutch release mechanism.

LUBRICATION

The transmission oil contained in the case splash lubricates all internal gears, bearings and shafts. Always maintain proper lube oil levels to assure a protective oil film on all loaded surfaces of gears and bearings. If fluid level is too low, metal to metal contact which causes scoring,scuffing and seizure could occur. If the level is too high, oil may be forced out of the case through the mainshaft openings.

Initial Service Interval

The initial "factory fill" lubricant should be drained between the first 3,000 to 5,000 miles (4,827 to 8,045 km).

CAUTION

During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles throughout the transmission and may cause excessive wear. Remove all metal particles found on the magnetic plug(s).

Periodic Service Interval

Every 50,000 miles (80,000 km) or 1,500 operating hours the transmission oil should be changed. Use lubrication specification S-13 (Mineral Gear Oil - MOBIL Mobilube C) or S-3 (Heavy Duty Engine Oil - MOBIL Super). In temperatures below 10 °F. use lubrication specification S-14 (Mineral Gear Oil - MOBIL Mobilube C) or S-4 (Heavy Duty Engine Oil - MOBIL Super) as shown in Section 10 of this manual.

1. Operate the transmission until normal operating temperature is reached.
2. Remove the bottom drain plug(s) and drain the oil while warm.
3. Fill through dipstick tube to dipstick full level mark. On transmissions without dipstick, remove the side fill plug and refill the transmission until oil level is even with bottom of hole.
4. Thoroughly clean the plug(s) before re-installing.

NOTE: Other lube oils may be substituted for the specifications listed above. Refer to the lubricant chart to determine the correct type and viscosity required. Different types or brands of oil should not be intermixed due to the possibility of oil component breakdown.

RECOMMENDED LUBRICANTS

Type	Grade (SAE)	Ambient Temperature
Heavy Duty Engine Oil MIL-L-2104C or MIL-L-46152 or API-SF or API-CD	50	Above 10°F (-12.2°C)
	40	Above 10°F (-12.2°C)
	30	Below 10°F (-12.2°C)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90	Above 10°F (-12.2°C)
	80W	Below 10°F (-12.2°C)
Mid EP Gear Oil* MIL-L-2105 or API-GL-4	90	10°F to 100° (-12.2°C to 38°C)
	80W	-15°F to 70°F (-26°C to 21°C)
Multipurpose Gear Oil* MIL-L-2105B or MIL-L-2105C or API-GL-5	85W144	Above 10°F (-12.2°C)
	80W140	Above -15°F (-26°C)
	90	10°F to 100°F (-12.2°C to 38°C)
	80W90	-15°F to 100°C (-26°C to 38°C)
	80W	15°F to 70° (-9.4°C to 21°C)
	75W	-40°F to 15°F (-40°C to 26°C)

*Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).

Lubricant Chart

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 11 of the removal procedure. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233. See "Service Tools" at end of this section.

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.
2. Drain the lubricant from the transmission, and remove the dipstick and tube if equipped.
3. Disconnect the reverse switch harness and tone ring speed sensor harness if equipped.
4. Loosen turnbuckle and unfasten the clutch release arm return springs.
5. Disconnect the clutch rear control cable from release arm.

6. Rotate the lever to permit the release yoke fork to turn up and pull free of the clutch release bearing.

7. Unfasten and remove the splined lever and slide release arm off shaft.

8. Disconnect the driveshaft from the transmission. Refer to the “Driveshaft Removal” procedure in section 14.

9. Disconnect the shift linkage from the LRC remote shift control box. Refer to the “Shift Linkage Removal” procedure in section 13D.

NOTE: Unfasten the selector rod from the shift lever and pivot link rod by removing cotter keys and nuts. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage. This will result in maladjustment of the linkage.

10. Remove the engine and transmission module as an assembly. Refer to the “Engine Removal” procedure shown in section 8A1 thru 8A4.

11. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ **CAUTION** ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent clutch and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

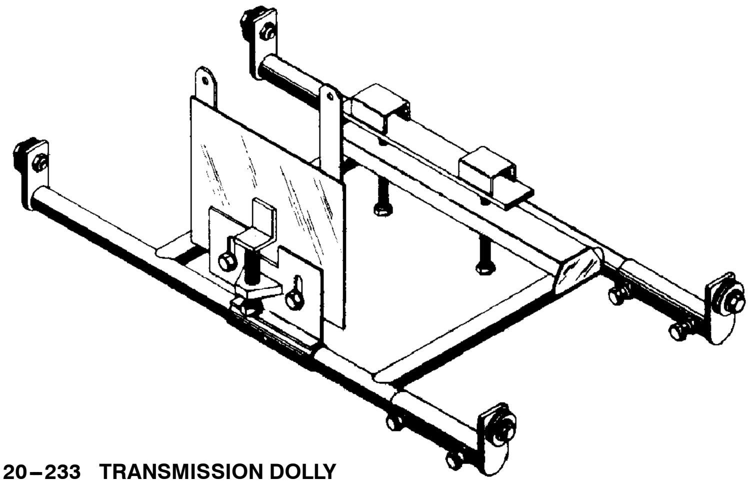
NOTE: Inspect the engine-to-transmission mounting surfaces, pilot shaft bearing and bearing mount in flywheel for any signs of wear.

INSTALLATION

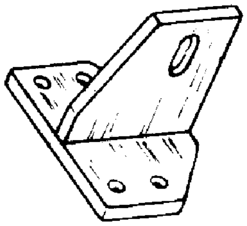
1. Install the transmission in reverse order of the “Removal” procedure. Refer to the “Yoke to Bearing Installation” procedure in section 5, and the “Shift Linkage Installation” procedure in section 13D when reinstalling the transmission.

SERVICE TOOLS

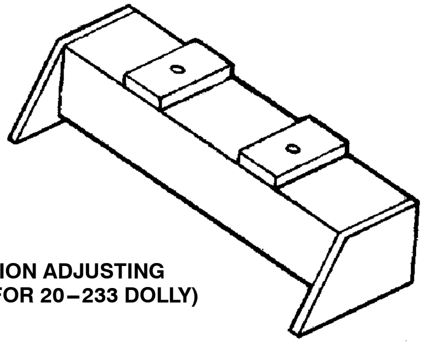
SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IT THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



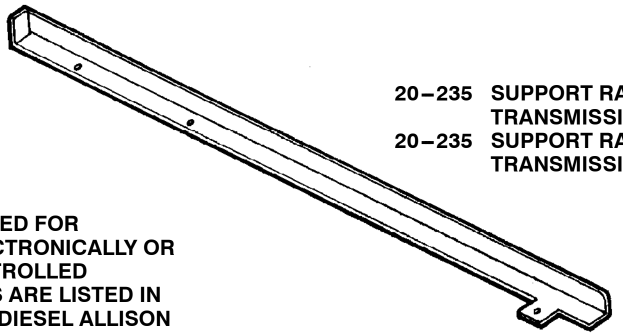
20–233 TRANSMISSION DOLLY
(FOR 3-AXLE COACH ONLY)



20–57 LIFTER PLATE ASSEMBLY
ALLISON TRANSMISSION



20–234 TRANSMISSION ADJUSTING
CHANNEL (FOR 20–233 DOLLY)



20–235 SUPPORT RAIL-L.H. FOR 20–233
TRANSMISSION DOLLY
20–235 SUPPORT RAIL-R.H. FOR 20–233
TRANSMISSION DOLLY

NOTE: THE SPECIAL TOOLS REQUIRED FOR SERVICING EITHER THE ELECTRONICALLY OR NON-ELECTRONICALLY CONTROLLED AUTOMATIC TRANSMISSIONS ARE LISTED IN THE APPROPRIATE DETROIT DIESEL ALLISON SERVICE MANUAL.

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TORQUE SPECIFICATIONS

Main Drive Gear Bearing Nut	250-300 ft-lbs
Mainshaft Rear Bearing Cover Capscrews	35-45 ft-lbs
Clutch Housing Capscrews	90-100 ft-lbs
Clutch Housing Hand Hole Cover Capscrews	20-25 ft-lbs
Front Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Rear Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Oil Drain Plug	45-55 ft-lbs
Oil Fill Plug	60-75 ft-lbs
Output Shaft Yoke Nut	400-450 ft-lbs
Shift Bar Housing Capscrews	35-45 ft-lbs
LRC Remote Shift Control Housing Capscrews	35-45 ft-lbs
Reverse & Neutral Signal Switches	35-45 ft-lbs

SPECIFICATIONS

TRANSMISSION ASSEMBLY

Manufacturer	Eaton/Fuller
Part Number (Model T-11605-D)	13L-1-80
Part Number (Model T-11605-D W/Tone Ring)	13L-1-151
Part Number (Model T-11605-F)	13L-1-81
Part Number (Model T-11605-F W/Tone Ring)	13L-1-153

TRANSMISSION GEAR RATIOS

First Gear (Model T-11605-D)	5.46
First Gear (Model T-11605-F)	7.20
Second Gear (Model T-11605-D)	3.23
Second Gear (Model T-11605-F)	3.90
Third Gear (Model T-11605-D)	2.05
Third Gear (Model T-11605-F)	2.12
Fourth Gear (Model T-11605-D)	1.31
Fourth Gear (Model T-11605-F)	1.46
Fifth Gear (Model T-11605-D)	1.00
Fifth Gear (Model T-11605-F)	1.00
Reverse Gear (Model T-11605-D)	5.57
Reverse Gear (Model T-11605-F)	7.09

CAPACITY SCHEDULE

T-11605-D	Initial Factory Fill: 22 Pts. (10 L)	Service Fill: 22 Pts. (10 L)
T-11605-F	Initial Factory Fill: 22 Pts. (10 L)	Service Fill: 22 Pts. (10 L)

SECTION 13A2

MANUAL TRANSMISSION (7-SPEED)

CONTENTS OF THIS SECTION

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Operation 13A2-2
Maintenance 13A2-3
Service Tools 13A2-5
Torque Specifications 13A2-6
Specifications 13A2-6
Capacity Schedule 13A2-6

GENERAL DESCRIPTION

Some D Series coaches may be equipped with the Fuller® Model T-14607-A or TX-14607-B 7-speed manual transmission (Figure 1). These transmissions are designed with seven forward speeds and one reverse. This series transmission is rated for engines up to 400 hp, and 1,400 ft-lbs torque (1897 N·m).

These transmissions feature heavy-duty cast steel housings, twin countershaft gear arrangements, fine pitch “multi-mesh” gearing, two-piece input shaft and drive gear design, remote shift control and integral clutch housing release mechanism.

Transmissions are shifted via a shift linkage connecting the lever actuated master shift control to the transmission mounted remote slave shift control box. A standard four rail shift pattern is used for shifting function (Figure 2). See section 13D for more information on the SCR master shift control and LRC remote shift control boxes and the shift linkage.

The optional Model TX-14607-B “fuel saver” manual transmission may be utilized in conjunction with drive axles installations having 3.33 or 3.85 gear ratios. This combination provides for greater fuel economy. Gear ratios on the TX-14607-B differ from the T-14607-A.

COMPONENTS

COUNTERSHAFTS

Twin countershaft design divides the rated torque equally between two shafts. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of gears.

MAINSHAFT

The mainshaft assembly features the floating gear principle. These gears, when not engaged by the slide clutch gears, “float” on or between their adjacent twin countershaft gears, eliminating the need for gear sleeves and bushings.

NOTE: Only the countershaft gears which mate with multi-mesh mainshaft gears have fine pitch gearing (i.e., first and reverse gears are of the coarse pitch conventional gearing type).

HOUSING

The clutch housing mounts to the engine, and the gear case and clutch housings bolt directly to each other. The gear case provides for oil sump, fill and drain plugs, remote shift control mounting and various bearing and inspection hand hole covers.

CLUTCH RELEASE MECHANISM

The clutch housing incorporates provisions for the pull-type clutch release bearing carrier, release yoke, shafts and adjustable actuating arm. The clutch control housing incorporates lube galleries for greasing the release bearing shafts. For more information regarding the release mechanism, see section 5.

SHIFT BAR HOUSING

The shift bar housing contains the shift forks that slide the clutch gears forward or backward to engage a specific gear. The LRC remote shift control is mounted to the top of the shift bar housing and actuates the shift forks.

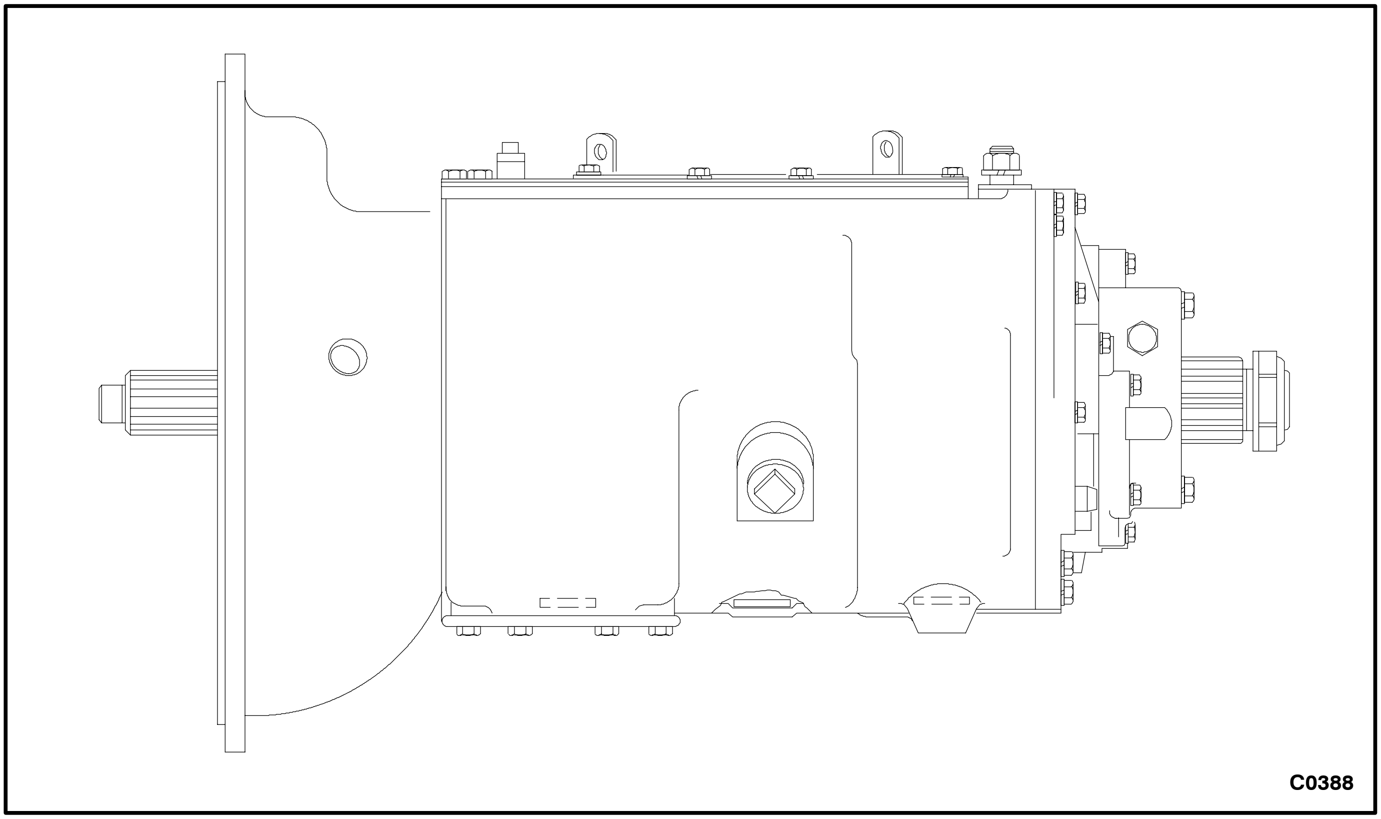


Figure 1. T-14607 Transmission

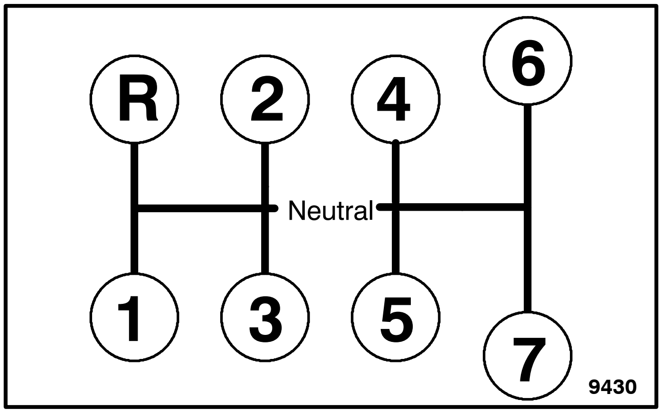


Figure 2. 7-Speed Shift Pattern

NOTE: There is a longer throw in the 6th and 7th shift patterns, which indicates the increased engagement contact of the sliding clutch gear teeth.

DIPSTICK & FILL TUBE

A dipstick and filler tube are installed into the transmissions for easy filling and checking of transmission lubricant. Access to the dipstick and filler tube is through the LH rear side service door.

NOTE: Effective with unit 47701 the dipstick and filler tube will no longer be installed. The fill tube hole will be plugged.

OPERATION

To convert the constant high-speed, high-torque, rotational energy of the engine into a variable speed, higher torque low-inertia rotation that can be used to move the coach, the transmission must be able to be shifted from one gear range to another. Gear shifts are accomplished through an arrangement of four fork actuated sliding clutch gears positioned along the mainshaft of the transmission.

Input shaft rotation is transmitted to twin countershafts either side of the mainshaft. The countershafts are fitted with gears that continuously rotate and rotate a mating gear on the mainshaft. Rotating mainshaft gears are not directly coupled to the mainshaft, therefore, shaft rotation is achieved only by engagement of the slide clutch gears.

Each sliding fork of the shift bar housing is attached to one of the sliding clutch gears. As a shift fork is indexed for a specific speed via the remote shift control, the clutch gear moves to engage the inner gear of the adjacent front or rear mainshaft floating gear. Engagement into the rotating mainshaft gear causes the slide gear to rotate and turn the mainshaft and output shaft. The selection and engagement of a specific gear thereby increases or decreases the output shaft speed of the transmission.

MAINTENANCE

PERIODIC INSPECTIONS

Every 5,000 miles (8,000 km) or 150 operating hours clean the exterior of the transmission and make the following inspections:

1. Check all transmission to engine mounting fasteners.

2. Remove filler plug or dipstick and check lube oil level. Check for any oil leaks.

3. Check for correct adjustment and operation of the shift linkage and clutch release mechanism.

LUBRICATION

The transmission oil contained in the case splash lubricates all internal gears, bearings and shafts. Always maintain proper lube oil levels to assure a protective oil film on all loaded surfaces of gears and bearings. If fluid level is too low, metal to metal contact which causes scoring,scuffing and seizure could occur. If the level is too high, oil may be forced out of the case through the mainshaft openings.

Initial Service Interval

The initial “factory fill” lubricant should be drained between the first 3,000 to 5,000 miles (4,827 to 8,045 km).

CAUTION

During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles throughout the transmission and may cause excessive wear. Remove all metal particles found on the magnetic plug(s).

Every 50,000 miles (80,000 km) or 1,500 operating hours the transmission oil should be changed. Use lubrication specification S-13 (Mineral Gear Oil - MOBIL Mobilube C) or S-3 (Heavy Duty Engine Oil - MOBIL Super). In temperatures below 10 °F. use lubrication specification S-14 (Mineral Gear Oil - MOBIL Mobilube C) or S-4 (Heavy Duty Engine Oil - MOBIL Super) as shown in Section 10 of this manual.

1. Operate the transmission until normal operating temperature is reached.

2. Remove the bottom drain plug(s) and drain the oil while warm.

3. Fill through dipstick tube to dipstick full level mark. On transmissions without dipstick, remove the side fill plug and refill the transmission until oil level is even with bottom of hole.

4. Thoroughly clean the plug(s) before re-installing.

NOTE: Other lube oils may be substituted for the specifications listed above. Refer to the lubricant chart to determine the correct type and viscosity required. Different types or brands of oil should not be intermixed due to the possibility of oil component breakdown.

RECOMMENDED LUBRICANTS

Type	Grade (SAE)	Ambient Temperature
Heavy Duty Engine Oil MIL-L-2104C or MIL-L-46152 or API-SF or API-CD	50 40 30	Above 10°F (-12.2°C) Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90 80W	Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mid EP Gear Oil* MIL-L-2105 or API-GL-4	90 80W	10°F to 100° (-12.2°C to 38°C) -15°F to 70°F (-26°C to 21°C)
Multipurpose Gear Oil* MIL-L-2105B or MIL-L-2105C or API-GL-5	85W144 80W140 90 80W90 80W 75W	Above 10°F (-12.2°C) Above -15°F (-26°C) 10°F to 100°F (-12.2°C to 38°C) -15°F to 100°C (-26°C to 38°C) 15°F to 70° (-9.4°C to 21°C) -40°F to 15°F (-40°C to 26°C)

*Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).

Lubricant Chart

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 11 of the removal procedure. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233. See “Service Tools” at end of this section.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Drain the lubricant from the transmission, and remove the dipstick and tube if equipped.

3. Disconnect the reverse switch harness and tone ring speed sensor harness if equipped.

4. Loosen turnbuckle and unfasten the clutch release arm return springs.

5. Disconnect the clutch rear control cable from release arm.

6. Rotate the lever to permit the release yoke fork to turn up and pull free of the clutch release bearing.

7. Unfasten and remove the splined lever and slide release arm off shaft.

8. Disconnect the driveshaft from the transmission. Refer to the “Driveshaft Removal” procedure in section 14.

9. Disconnect the shift linkage from the LRC remote shift control box. Refer to the “Shift Linkage Removal” procedure in section 13D.

NOTE: Unfasten the selector rod from the shift lever and pivot link rod by removing cotter keys and nuts. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage. This will result in misadjustment of the linkage.

10. Remove the engine and transmission module as an assembly. Refer to the “Engine Removal” procedure shown in section 8A1 thru 8A4.

11. Disconnect the transmission bottom support mounting fasteners from the engine cradle if equipped.

12. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ **CAUTION** ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent clutch and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

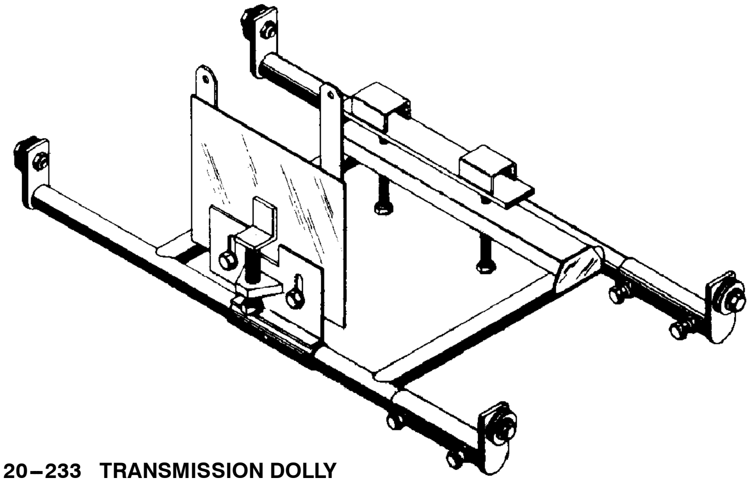
NOTE: Inspect the engine-to-transmission mounting surfaces, pilot shaft bearing and bearing mount in flywheel for any signs of wear.

INSTALLATION

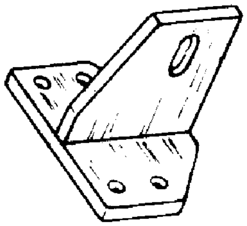
1. Install the transmission in reverse order of the “Removal” procedure. Refer to the “Yoke to Bearing Installation” procedure in section 5, and the “Shift Linkage Installation” procedure in section 13D when reinstalling the transmission.

SERVICE TOOLS

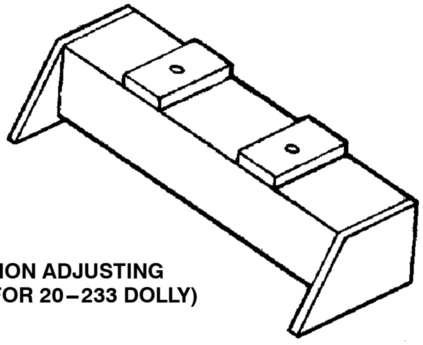
SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IT THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



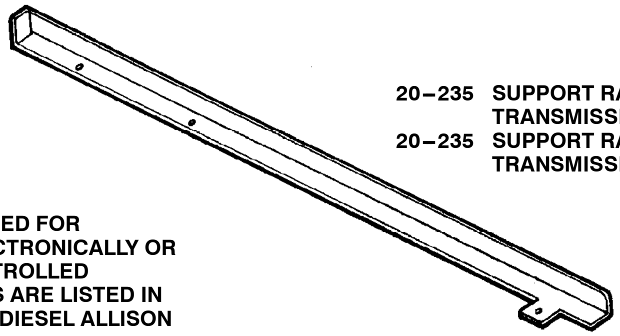
20−233 TRANSMISSION DOLLY
(FOR 3-AXLE COACH ONLY)



20−57 LIFTER PLATE ASSEMBLY
ALLISON TRANSMISSION



20−234 TRANSMISSION ADJUSTING
CHANNEL (FOR 20−233 DOLLY)



20−235 SUPPORT RAIL-L.H. FOR 20−233
TRANSMISSION DOLLY
20−235 SUPPORT RAIL-R.H. FOR 20−233
TRANSMISSION DOLLY

NOTE: THE SPECIAL TOOLS REQUIRED FOR SERVICING EITHER THE ELECTRONICALLY OR NON-ELECTRONICALLY CONTROLLED AUTOMATIC TRANSMISSIONS ARE LISTED IN THE APPROPRIATE DETROIT DIESEL ALLISON SERVICE MANUAL.

C0324

TORQUE SPECIFICATIONS

Main Drive Gear Bearing Nut	250-300 ft-lbs
Mainshaft Rear Bearing Cover Capscrews	35-45 ft-lbs
Clutch Housing Capscrews	90-100 ft-lbs
Clutch Housing Hand Hole Cover Capscrews	20-25 ft-lbs
Front Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Rear Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Oil Drain Plug	45-55 ft-lbs
Oil Fill Plug	60-75 ft-lbs
Output Shaft Yoke Nut	400-450 ft-lbs
Shift Bar Housing Capscrews	35-45 ft-lbs
LRC Remote Shift Control Housing Capscrews	35-45 ft-lbs
Reverse Signal Switch	35-45 ft-lbs

SPECIFICATIONS

TRANSMISSION ASSEMBLY

Manufacturer	Eaton/Fuller
Part Number (Model T-14607-A)	13L-1-82
Part Number (Model T-14607-A W/Tone Ring)	13L-1-155
Part Number (Model TX-14607-B)	13L-1-118
Part Number (Model TX-14607-B W/Tone Ring)	13L-1-157

TRANSMISSION GEAR RATIOS

First Gear (Model T-14607-A)	10.50
First Gear (Model TX-14607-B)	9.24
Second Gear (Model T-14607-A)	6.13
Second Gear (Model TX-14607-B)	5.35
Third Gear (Model T-14607-A)	3.71
Third Gear (Model TX-14607-B)	3.22
Fourth Gear (Model T-14607-A)	2.51
Fourth Gear (Model TX-14607-B)	2.04
Fifth Gear (Model T-14607-A)	1.83
Fifth Gear (Model TX-14607-B)	1.37
Sixth Gear (Model T-14607-A)	1.34
Sixth Gear (Model TX-14607-B)	1.00
Seventh Gear (Model T-14607-A)	1.00
Seventh Gear (Model TX-14607-B)	.75
Reverse Gear (Model T-14607-A)	10.20
Reverse Gear (Model TX-14607-B)	8.99

CAPACITY SCHEDULE

T-14607-A	Initial Factory Fill: 36 Pts. (17.5 L)	Service Fill: 36 Pts. (17.5 L)
TX-14607-B	Initial Factory Fill: 36 Pts. (17.5 L)	Service Fill: 36 Pts. (17.5 L)

SECTION 13A3

MANUAL TRANSMISSION (10-SPEED)

CONTENTS OF THIS SECTION

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Miscellaneous Torque Specifications 13A3-7
Specifications 13A3-7
Capacity Schedule 13A3-8

GENERAL DESCRIPTION

Some D Series coaches may be equipped with the Fuller® Model RTX-13710-B or RTLO-14610-A (semi-automatic air-assisted) 10-speed manual shift transmissions (Figure 1). These transmissions are designed with ten forward speeds, one high reverse and one low reverse gear. The RTX-13710-B series transmission is rated for engines up to 400 hp and 1,350 ft-lbs torque (1829 N·m), while the RTLO-14610-A series transmission is rated for engines up to 400 hp, and 1,450 ft-lbs torque (1936 N·m).

Additionally, some D Series coaches may be equipped with the Fuller® Model RTAO-14710-B-AS (semi-electronically controlled air-assisted) 10-speed auto-shifting transmission (Figure 2). This transmission features only one low reverse gear and ten forward gears. The RTAO-14710-B-AS transmission is rated for engines up to 400 hp and 1,450 ft-lbs torque (1936 N•m)

These transmissions feature heavy-duty cast steel housings, twin countershaft gear arrangements, fine pitch "multi-mesh" gearing, two-piece input shaft and drive gear design, repeat and non-repeating shift patterns (manually shifted transmissions), air actuated button operated range shifting, remote shift control and integral clutch housing release mechanism. Additionally, the RTAO-14710-B-AS series transmission features electronically controlled, dual servo motor automatic shifting within a specific transmission drive range.

The manually shifted transmissions select gears via a shift linkage connecting the lever actuated master shift control to the transmission mounted remote slave shift control box. A standard three rail repeat shift pattern is used along with air cylinder actuated range shifting function on the RTX-13710-B (Figure 3), while the auto-ranging RTLO-14610-A uses an air cylinder actuated splitter gear to achieve a non-repeat shift pattern (Figure 4). See section 13D for more information on the SCR master shift control and LRC remote shift control boxes and the shift linkage.

The auto-shifted RTAO-14710-B-AS transmission utilizes computer controlled electric shift motors connected to the standard three rail repeat pattern, and air cylinder actuated range shifting function.

NOTE: The number of conventional lever movements with the RTLO-14610-A "Super 10" is half that of conventional ten speeds. The auto range shift feature is triggered automatically as the operator moves the lever toward the third rail.

The RTAO-14710-B-AS auto shift transmission require clutch disengagment to select the drive range, either of the two lowest forward gears or the reverse gear.

The optional Model RTX-13710-B "fuel saver" manual transmission may be utilized in conjunction with drive axles installations having 3.33 or 3.85 gear ratios. This combination provides for greater fuel economy. Gear ratios on the RTX-13710-B differ from the RTLO-14610-A.

COMPONENTS

COUNTERSHAFTS

Twin countershaft design divides the rated torque equally between two shafts. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of gears.

MAINSHAFT

The mainshaft assembly features the floating gear principle. These gears, when not engaged by the slide clutch gears, "float" on or between their adjacent twin countershaft gears, eliminating the need for gear sleeves and bushings.

NOTE: Only the countershaft gears which mate with multi-mesh mainshaft gears have fine pitch gearing (i.e., first and reverse gears are of the corse pitch conventional gearing type).

HOUSING

The clutch housing mounts to the engine, and the gear case and clutch housings bolt directly to each other. The gear case provides for oil sump, fill and drain plugs, remote shift control mounting and various bearing and inspection hand hole covers.

CLUTCH RELEASE MECHANISM

The clutch housing incorporates provisions for the pull-type clutch release bearing carrier, release yoke, shafts and adjustable actuating arm. The clutch control housing incorporates lube galleries for greasing the release bearing shafts. For more information regarding the release mechanism see section 5.

ELECTRONIC CONTROL

The shift bar housing servo motors are controlled by the ECU of the control components. The ECU is attached to the transmission and connected to the engine ECU, shift selector, speed sensors and other transmission control devices through wire harness.

NOTE: Engine and transmission electronic control systems will incorporate an interface module between ECU modules.

SHIFT BAR HOUSING

The shift bar housing on manually shifted transmissions contain the shift forks that slide the clutch gears forward or backward to engage a specific gear. The LRC remote shift control is mounted to the top of the shift bar housing and actuates the shift forks.

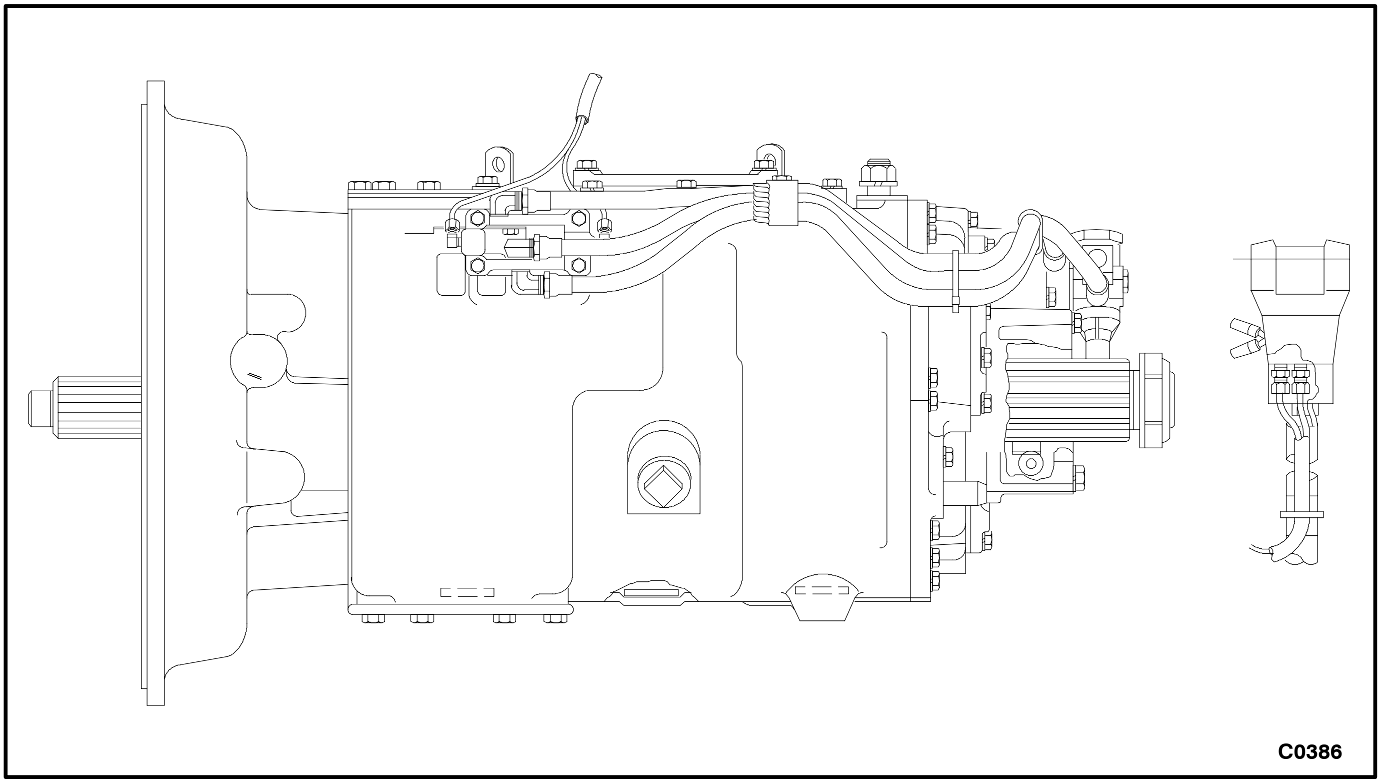

Figure 1. RTLO-14610 "Super 10" Transmission

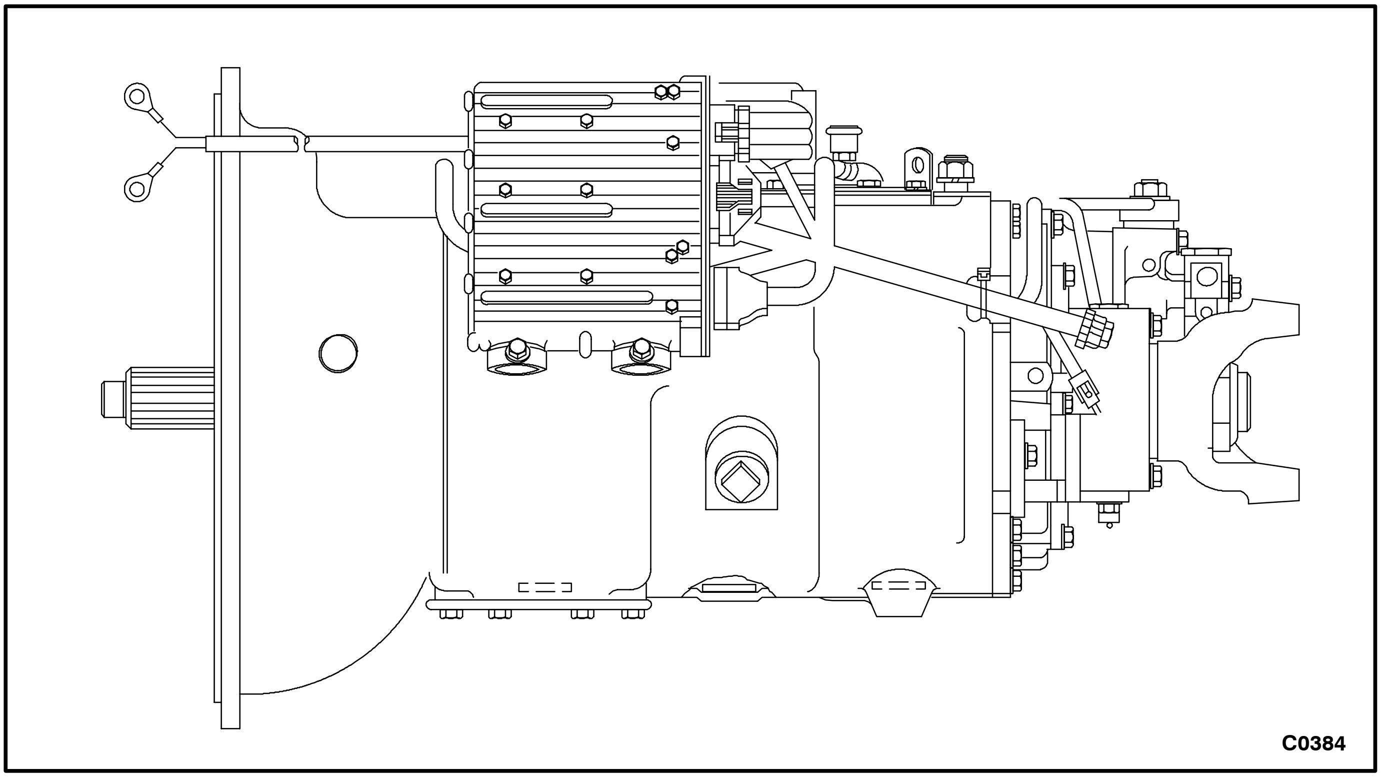

Figure 2. RTAO-14710 Auto-Shift Transmission

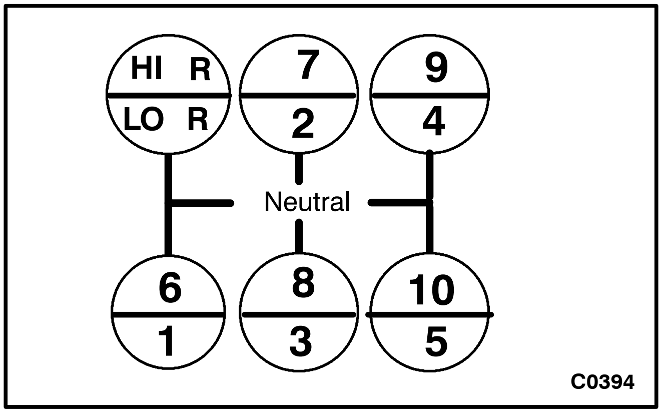

Figure 3. 10-Speed Repeat Shift Pattern

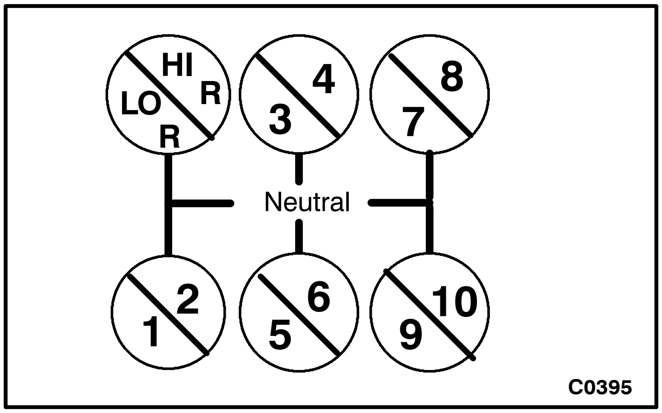

Figure 4. 10-Speed Non-Repeat Shift Pattern

The shift bar housing on the electronically controlled auto shift transmission is fitted with dual electric indexing (lateral and longitudinal direction) motors that actuate the shift forks and slide the clutch gears forward or backward to engage gears. The motor commands are directed by the electronic control system ECU.

DIPSTICK & FILL TUBE

A dipstick and filler tube are installed into the transmissions for easy filling and checking of transmission lubricant. Access to the dipstick and filler tube is through the LH rear side service door.

NOTE: Effective with unit 47701 the dipstick and filler tube will no longer be installed. The fill tube hole will be plugged.

SHIFT SELECTOR MODULE

The auto shifted 10-speed transmissions utilize a shift by wire system consisting of the Eaton Driver Command Console (DCC) selector control module. This module is connected to the transmission ECU by harness. The shift selector control module may use either lever actuated or touch pad type control (Figure 5).

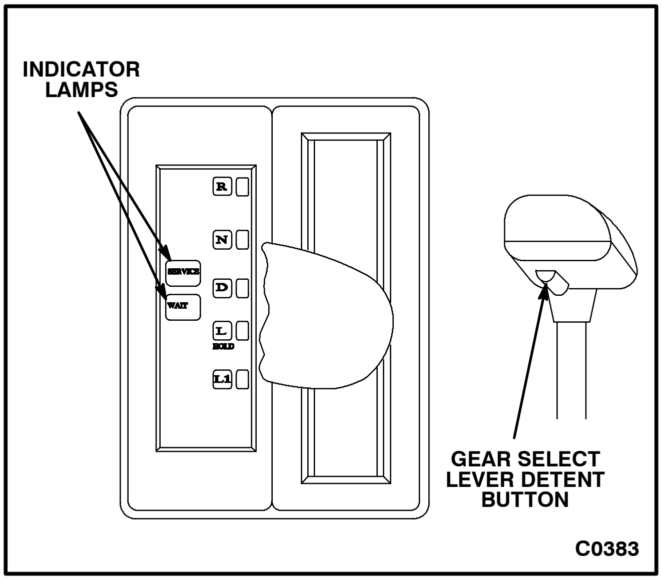

Figure 5. 10-Speed Auto-Shift

OPERATION

To convert the constant high-speed, high-torque, rotational energy of the engine into a variable speed, higher torque low-inertia rotation that can be used to move the coach, the transmission must be able to be shifted from one gear range to another. Gear shifts are accomplished through an arrangement of four fork actuated sliding clutch gears positioned along the mainshaft of the transmission.

Input shaft rotation is transmitted to twin countershafts either side of the mainshaft. The countershafts are fitted with gears that continuously rotate and rotate a mating gear on the mainshaft. Rotating mainshaft gears are not directly coupled to the mainshaft, therefore, shaft rotation is achieved only by engagement of the slide clutch gears.

Each sliding fork of the shift bar housing is attached to one of the sliding clutch gears. As a shift fork is indexed for a specific speed via the remote shift control, the clutch gear moves to engage the inner gear of the adjacent front or rear mainshaft floating gear. Engagement into the rotating mainshaft gear causes the slide gear to rotate and turn the mainshaft and output shaft. The selection and engagement of a specific gear thereby increases or decreases the output shaft speed of the transmission.

The model RTX-13710-B and RTLO-14610-A transmissions utilizes an air actuated range control air cylinder to shift into the higher range of gears. Activation of the lever mounted air control switch allows air to flow to the range cylinder via the control valve. The cylinder is connected to the auxiliary mainshaft synchronizer assembly fork, located in the auxiliary gear case. Fork movement will option either the low or high gear ranges.

Additionally, the RTLO-14610-A uses a splitter air cylinder to shift the slide clutch gear that either engages or disengages the the splitter gear, which in turn engages or disengages the front box from the rear auxiliary box and countershaft.

Shifting of the RTAO-1470-B-AS auto shift transmission is performed through the electronic lever or touch pad shift selector module. into the “D” (drive) range will allow the electronic control system ECU to automatically upshift or downshift the transmission as needed. The clutch must be used (disengaged) when shifting into the “D” range from any other previously selected gear. This electrically shifted transmission also utilizes and control the air actuated range cylinder operations for range shift functions.

MAINTENANCE

PERIODIC INSPECTIONS

Every 5,000 miles (8,000 km) or 150 operating hours clean the exterior of the transmission and make the following inspections:

1. Check all transmission to engine mounting fasteners.
2. Check for any loose electrical harnesses or air line connections.
3. Remove filler plug or dipstick and check lube oil level. Check for any oil leaks.
4. Check for correct adjustment and operation of the shift linkage and clutch release mechanism.
5. Clean al dirt, dust and foreign objects off the shift selector module. Keep foreign objects and liquids away from shift console.

LUBRICATION

The transmissions are designed so that all internal parts including gears, bearings and shafts are either splash lubricated, or operate in an oil bath that is circulated by the motion of the gears and shafts. Always maintain proper lube oil levels to assure a protective oil film on all loaded surfaces of gears and bearings. If fluid level is too low, metal to metal contact which causes scoring,scuffing and seizure could occur.

NOTE: If the level is too high, oil may be forced out of the case through the mainshaft openings.

Initial Service Interval

The initial “factory fill” lubricant should be drained between the first 3,000 to 5,000 miles (4,827 to 8,045 km).

CAUTION

During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles throughout the transmission and may cause excessive wear. Remove all metal particles found on the magnetic plug(s).

Normal Service Interval

On manually shifted Fuller models RTX-13710-B and RTLO-14610-A the transmission oil should be changed every 50,000 miles (80,000 km) or 1,500 operating hours. Use lubrication specification S-13 (Mineral Gear Oil - MOBIL Mobilube C) or S-3 (Heavy Duty Engine Oil - MOBIL Super). In temperatures below 10 °F. use lubrication specification S-14 (Mineral Gear Oil - MOBIL Mobilube C) or S-4 (Heavy Duty Engine Oil - MOBIL Super) as shown in Section 10 of this manual.

NOTE: Other lube oils may be substituted for the manually shifted models lubrication specifications listed above. Refer to the lubricant chart to determine the correct type and viscosity required. Different types or brands of oil should not be intermixed due to the possibility of oil component breakdown.

On the auto shifted Fuller model RTAO-14710-B-AS the transmission fluid should be changed every 250,000 miles (402,000 km) or 7,500 operating hours the synthetic transmission fluid should be changed. Use lubrication specification S-27 (Synthetic Manual Transmission Gear Oil - EATON Roadranger CD50 or MOBIL Mobiltrans SHC-50).

1. Operate the transmission until normal operating temperature is reached.
2. Remove the bottom drain plug(s) and drain the oil while warm.
3. Fill through dipstick tube to dipstick full level mark. On transmissions without dipstick, remove the side fill plug and refill the transmission until oil level is even with bottom of hole.
4. Thoroughly clean the plug(s) before re-installing.

RECOMMENDED LUBRICANTS

Type	Grade (SAE)	Ambient Temperature
Heavy Duty Engine Oil MIL-L-2104C or MIL-L-46152 or API-SF or API-CD	50 40 30	Above 10°F (-12.2°C) Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90 80W	Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mid EP Gear Oil* MIL-L-2105 or API-GL-4	90 80W	10°F to 100° (-12.2°C to 38°C) -15°F to 70°F (-26°C to 21°C)
Multipurpose Gear Oil* MIL-L-2105B or MIL-L-2105C or API-GL-5	85W144 80W140 90 80W90 80W 75W	Above 10°F (-12.2°C) Above -15°F (-26°C) 10°F to 100°F (-12.2°C to 38°C) -15°F to 100°C (-26°C to 38°C) 15°F to 70° (-9.4°C to 21°C) -40°F to 15°F (-40°C to 26°C)

*Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).

Lubricant Chart

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 11 of the removal procedure. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233. See “Service Tools” at end of this section.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.
2. Drain the lubricant from the transmission, and remove the dipstick and tube if equipped.
3. Disconnect the reverse switch harness and tone ring speed sensor harness if equipped. On auto shift transmissions disconnect the engine ECU and shift module harness.
4. Loosen turnbuckle and unfasten the clutch release arm return springs.
5. Disconnect the clutch rear control cable from release arm.
6. Rotate the lever to permit the release yoke fork to turn up and pull free of the clutch release bearing.
7. Unfasten and remove the splined lever and slide release arm off shaft.
8. Disconnect the transmission air line.
9. Disconnect the driveshaft from the transmission. Refer to the “Driveshaft Removal” procedure in section 14.

10. On manually shifted transmissions disconnect the shift linkage from the LRC remote shift control box. Refer to the “Shift Linkage Removal” procedure in section 13D.

NOTE: Unfasten the selector rod from the shift lever and pivot link rod by removing cotter keys and nuts. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage. This will result in maladjustment of the linkage.

11. Remove the engine and transmission module as an assembly. Refer to the “Engine Removal” procedure shown in section 8A1 thru 8A4.

12. Disconnect the transmission bottom support mounting fasteners from the engine cradle if equipped.

13. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ **CAUTION** ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent clutch and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

NOTE: Inspect the engine-to-transmission mounting surfaces, pilot shaft bearing and bearing mount in flywheel for any signs of wear.

INSTALLATION

1. Install the transmission in reverse order of the “Removal” procedure. Refer to the “Yoke to Bearing Installation” procedure in section 5, and the “Shift Linkage Installation” procedure in section 13D when reinstalling the transmission.

MISCELLANEOUS TORQUE SPECIFICATIONS

Main Drive Gear Bearing Nut	250-300 ft-lbs
Mainshaft Rear Bearing Cover Capscrews	35-45 ft-lbs
Clutch Housing Capscrews	90-100 ft-lbs
Clutch Housing Hand Hole Cover Capscrews	20-25 ft-lbs
Front Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Rear Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Oil Drain Plug	45-55 ft-lbs
Oil Fill Plug	60-75 ft-lbs
Output Shaft Yoke Nut	400-450 ft-lbs
Shift Bar Housing Capscrews	35-45 ft-lbs
LRC Remote Shift Control Housing Capscrews	35-45 ft-lbs
Reverse Signal Switch	35-45 ft-lbs

SPECIFICATIONS

TRANSMISSION ASSEMBLY

Manufacturer	Eaton/Fuller
Part Number (Model RTX-13710-B W/Tone Ring)	13L-1-106
Part Number (Model RTLO-14610-A W/Tone Ring)	13L-1-145
Part Number (Model RTAO-14710-B-AS)	13L-1-150

GEAR RATIOS - MODEL RTX-13710-B

First Gear (Model RTX-13710-B)	10.99
Second Gear (Model RTX-13710-B)	8.18
Third Gear (Model RTX-13710-B)	6.07
Fourth Gear (Model RTX-13710-B)	4.46
Fifth Gear (Model RTX-13710-B)	3.32
Sixth Gear (Model RTX-13710-B)	2.46
Seventh Gear (Model RTX-13710-B)	1.83
Eight Gear (Model RTX-13710-B)	1.36
Ninth Gear (Model RTX-13710-B)	1.00
Tenth Gear (Model RTX-13710-B)	.74
HI Reverse Gear (Model RTX-13710-B)	2.52
LO Reverse Gear (Model RTX-13710-B)	11.23

GEAR RATIOS - MODEL RTLO-14610-A

First Gear (Model RTLO-14610-A)	11.06
Second Gear (Model RTLO-14610-A)	8.20
Third Gear (Model RTLO-14610-A)	6.06
Fourth Gear (Model RTLO-14610-A)	4.49
Fifth Gear (Model RTLO-14610-A)	3.32
Sixth Gear (Model RTLO-14610-A)	2.46
Seventh Gear (Model RTLO-14610-A)	1.82
Eight Gear (Model RTLO-14610-A)	1.35
Ninth Gear (Model RTLO-14610-A)	1.00
Tenth Gear (Model RTLO-14610-A)	.74
HI Reverse Gear (Model RTLO-14610-A)	9.58
LO Reverse Gear (Model RTLO-14610-A)	12.93

SPECIFICATIONS (Contd.)

GEAR RATIOS - MODEL RTAO-14710-B-AS

First Gear (Model RTAO-14710-B-AS)	10.99
Second Gear (Model RTAO-14710-B-AS)	8.18
Third Gear (Model RTAO-14710-B-AS)	6.07
Fourth Gear (Model RTAO-14710-B-AS)	4.46
Fifth Gear (Model RTAO-14710-B-AS)	3.32
Sixth Gear (Model RTAO-14710-B-AS)	2.46
Seventh Gear (Model RTAO-14710-B-AS)	1.83
Eight Gear (Model RTAO-14710-B-AS)	1.36
Ninth Gear (Model RTAO-14710-B-AS)	1.00
Tenth Gear (Model RTAO-14710-B-AS)	.74
LO Reverse Gear (Model RTAO-14710-B-AS)	11.23

CAPACITY SCHEDULE

RTX-13710-B	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
RTL-14610-A	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
RTA-14710-B	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)

SECTION 13A4

SHIFT CONTROLS

CONTENTS OF THIS SECTION

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Components 13A4-1
Maintenance 13A4-3
Specifications 13A4-5

GENERAL DESCRIPTION

The D Series coaches equipped with manual transmission installations will feature a mechanically actuated remote shifting arrangement. The driver operated shift lever connects to a master shift control box, which is interconnected via shift linkage to the transmission mounted remote shift control box. Each sliding fork of the transmission shift bar housing may be indexed for a specific shift via the remote shift control. The remote control box mimics the master control box shift lever selections to shift the transmission into a desired gear or range of gears.

In addition to the mechanically operated shift components, all ten speed transmissions feature air assisted auto or manual activated range (and/or gear) shifting. Supply air is utilized to actuate specific air cylinders mounted on the transmission effecting specific reductions or auxiliary gear case activation.

COMPONENTS

SHIFT LEVER

The floor mounted shift lever is located to the right of the driver. The lever is connected to the SCR master shift control box. Standard three and four rail shift patterns are shown for the 5-speed and 7-speed transmissions (Figures 1 & 2) The RTX-13710-B ten-speed transmission utilizes a three rail simple repeat pattern (Figure 3) while the RTLO-14610-A "super 10" ten-speed features a three rail non-repeat pattern (Figure 4).

The air assisted ranging function is optioned by the shift lever knob air control valve button. Activation of the air control valve button allows air to flow to the control port of the air valve and on to the range cylinder. Similar air control components are used to shift the auxiliary gear case of the auto-ranging "super 10" transmissions, however, a second splitter cylinder is also actuated.

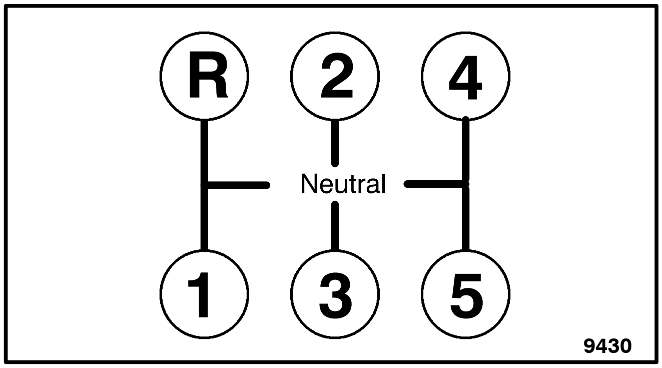


Figure 1. 5-Speed Shift Pattern

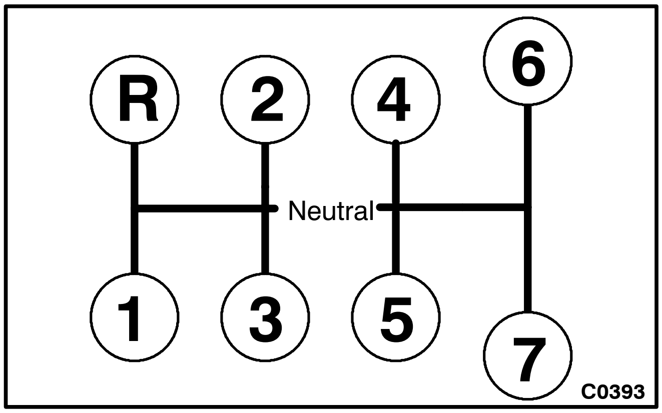


Figure 2. 7-Speed Shift Pattern

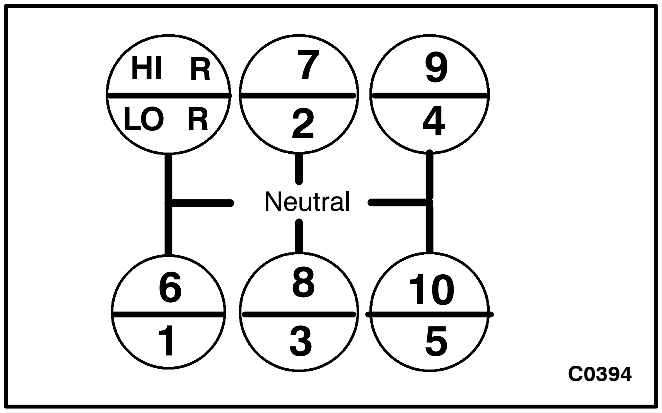


Figure 3. 10-Speed Repeat Shift Pattern

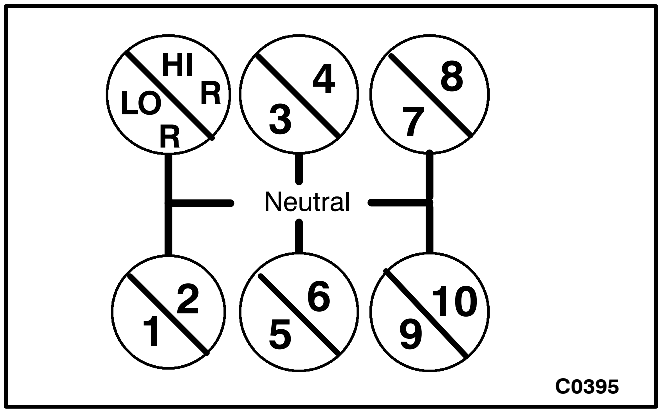


Figure 4. 10-Speed Non-Repeat Shift Pattern

MASTER SHIFT CONTROL

The SRC master control box is located beneath the floor mounted shift lever. The master control transmits the movements of the shift lever to the shift linkage.

SHIFT LINKAGE

The shift linkage runs the length of the coach within the center tunnel. The linkage transmits the movements of the shift lever to the selector lever of the remote shift control box. A turnbuckle adjustment is incorporated at the rear of the linkage for positive shifting.

REMOTE SHIFT CONTROL

The LRC remote shift control is mounted to the top of the shift bar housing. The shift linkage is attached to a threaded selector lever, which in turn is connected to the inner shift shaft of the remote control box via a shift lever. The selector lever is also connected to a stationary pivot link assembly that keep selector lever in proper alignment (Figure 5). The inner shift shaft is fitted with the inner shift finger that controls shift fork function.

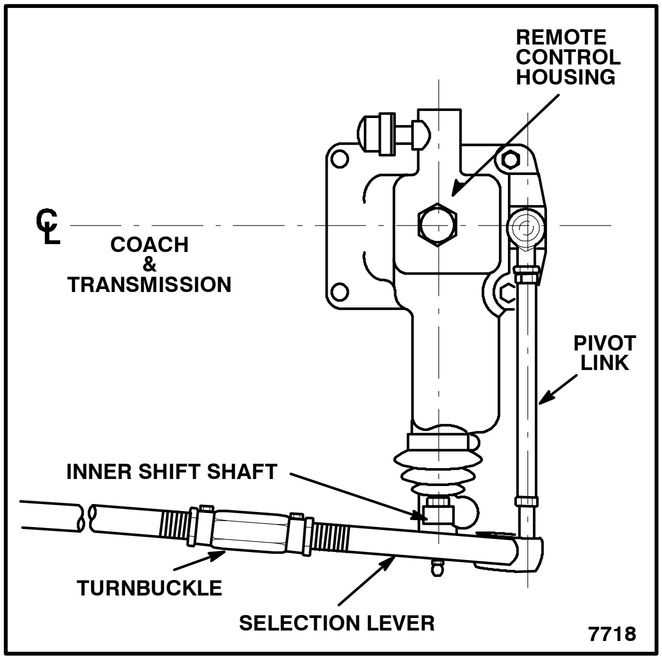


Figure 5. Remote Box Shift Linkage

RANGE CYLINDER

The model RTX-13710-B and RTLO-14610-A transmissions utilizes an air actuated range control air cylinder to shift into the higher range of gears. Activation of the lever mounted air control switch allows air to flow to the range cylinder via the control valve. The cylinder is connected to the auxiliary mainshaft synchronizer assembly fork, located in the auxiliary gear case. Fork movement will option either the low or high gear ranges.

SPLITTER CYLINDER

Additionally, the RTLO-14610-A uses a splitter air cylinder to shift the slide clutch gear that either engages or disengages the the splitter gear, which in turn engages or disengages the rear auxiliary box and countershaft to the front box.

CONTROL VALVE

Both the model RTX-13710-B and the RTLO-14610-A uses an air cylinder control valve to route air to a specific cylinder during transmission operation. Both valves receive supply air from the filter regulator attached to the rear of the transmission. Control port air is supplied through the master air control valve located on the shift lever. The RTLO-14610-A control valve is mounted to the top of the transmission, while the RTX-13710-B valve is mounted on the side.

MAINTENANCE

LUBRICATION

Lubrication of the entire shift linkage is recommended at 75,000 mile (121,000 km) or 2,250 operating hours. Lubricate the master and slave shift control boxes, carrier bearings, U-joints and all ball joints of the linkage through the grease fittings provided. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL-MOBILITH AW-1).

NOTE: Front U-joints and bearings lube fittings are access through the front bogie fitting and tire compartment, while the rear U-joint and bearings are accessed at the rear bogie cover.

ADJUSTMENT

Proper adjustment of the LRC remote control shift linkage is necessary for smooth shift operations. When adjusting the shift linkage, follow the procedures outlined below in order to insure that the linkage is set properly for smooth and trouble-free operation.

Slave Control Linkage

1. Place battery disconnect switch “Off”. Apply the parking brake.
2. Move the gear shift lever forward or backward to place inner shift shaft shift finger in the neutral position.
3. Move the the gear shift lever sideways, towards reverse, until resistance from the reverse plunger spring is felt. Do not overcome this spring tension, and leave the inner shift shaft shift finger in this position while making adjustments.
4. Unfasten and remove the pivot link cotter pin, castle nut and ball joint from the selection lever (Figure 6). Do not remove the ball joint from the pivot link.

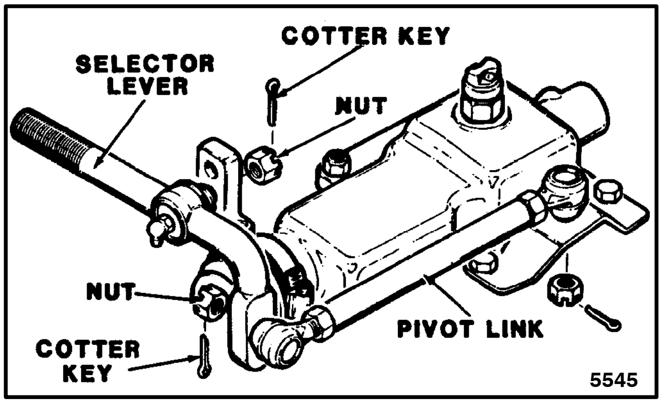


Figure 6. Disconnecting Shift Linkage

5. Unfasten and remove the capscrew retaining the shift arm to the inner shift shaft. Do not disconnect the selection lever from the shift arm (Figure 7).

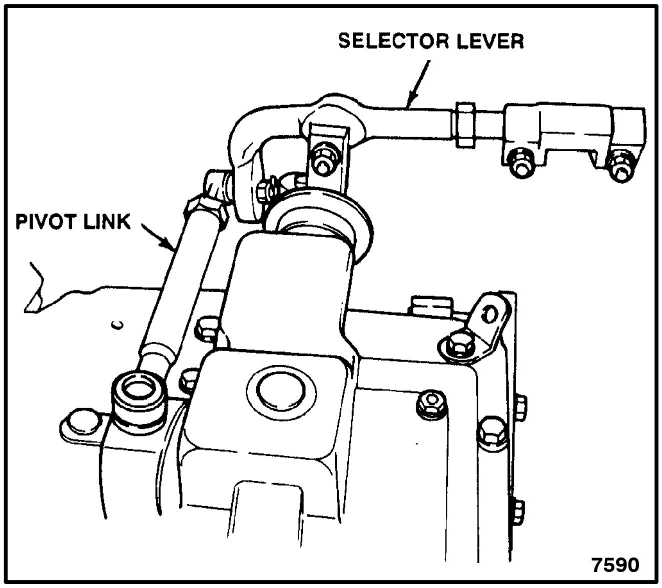


Figure 7. Selector Lever to Shift Arm

6. Turn the shift arm until it is at a right angle (90 degree) to the selection lever as viewed from the side (Figure 8).

NOTE: Ideally, the shift arm should be adjusted 90° to the selection lever as described, but in some chassis configurations it may be necessary to index the shift arm in the vertical position. This is done to prevent a “shift lever jump out condition”. This type adjustment will cause an unequal amount of gear shift lever travel between neutral and a forward lever position as compared to a neutral to rearward lever position.

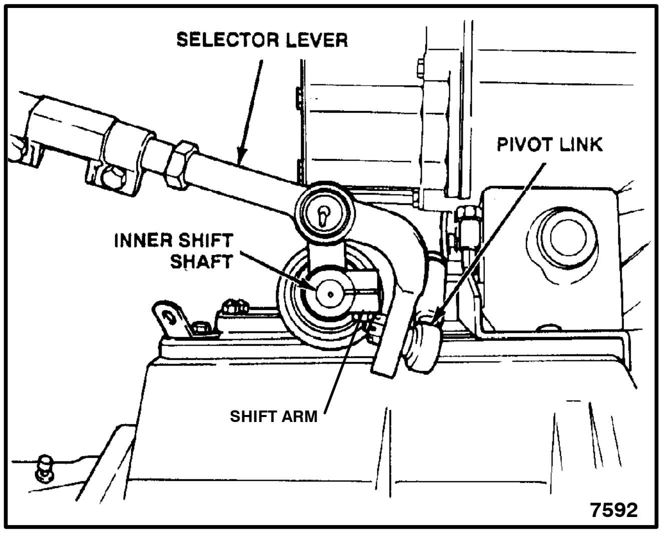


Figure 8. Linkage Components

7. Reinstall the shift arm on the splines of the inner shift shaft and tighten. The shift arm may have to be moved 4 or 5 degrees to align the splines of the two parts.

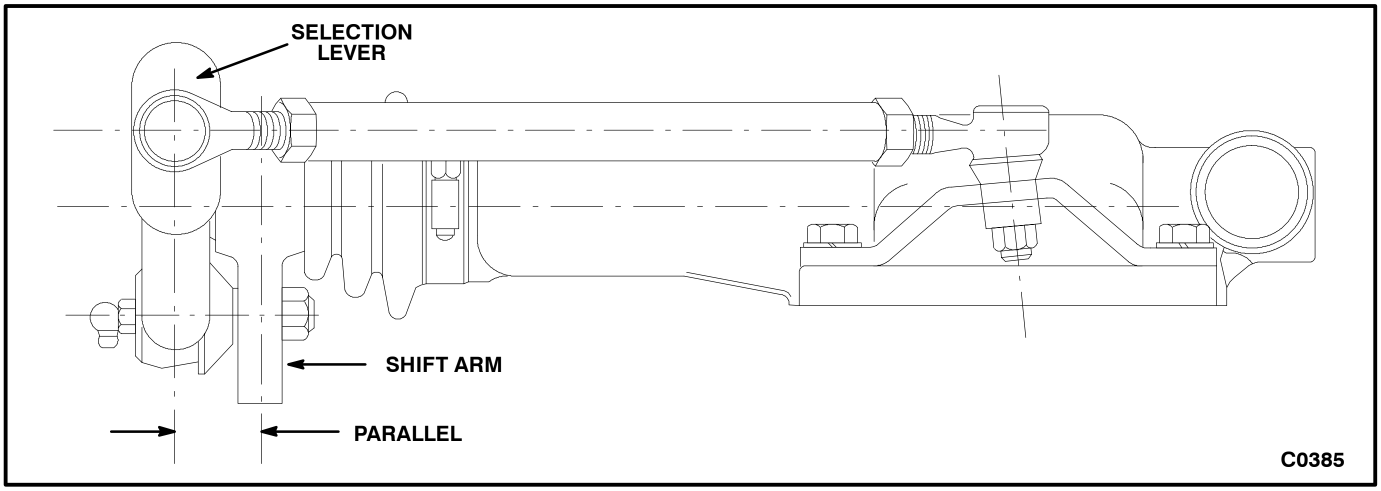

SELECTION LEVER
SHIFT ARM
PARALLEL
C0385

Figure 9. Pivot Link Alignment

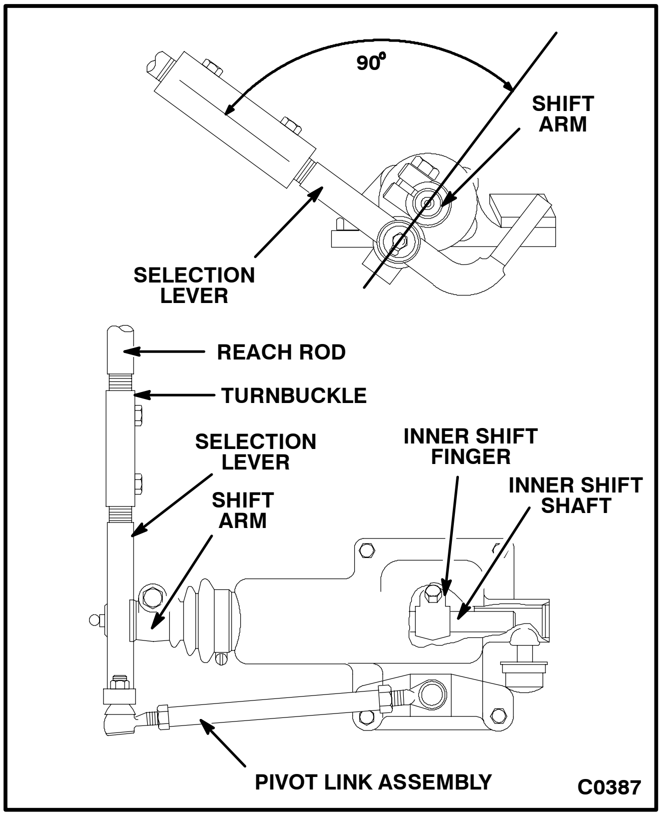

90°
SHIFT ARM
SELECTION LEVER
REACH ROD
TURNBUCKLE
SELECTION LEVER
SHIFT ARM
INNER SHIFT FINGER
INNER SHIFT SHAFT
PIVOT LINK ASSEMBLY
C0387

Figure 10. Components

8. Reconnect pivot link assembly ball joint to selection lever and secure.

9. Loosen the jam nuts on both ends of the pivot link, and rotate pivot link until curved end of selection lever is parallel with the shift arm as viewed from the rear (Figure 9).

NOTE: Inner shift finger must still be positioned as described in steps 1 and 2.

Shift Lever (Neutral)

1. Loosen both capscrews on the turnbuckle linear adjustment at rear linkage reach rod to selection lever (Figure 10).

NOTE: Again, check that inner shift finger is still positioned as described in steps 1 and 2 of the previous adjustment procedure.

2. Rotate turnbuckle to obtain the proper forward or rearward (neutral) position of the gear shift lever.
3. Tighten one of the turnbuckle clamp capscrews to secure this adjustment.
4. Move the gear shift lever to the desired left-right (neutral) position, and tighten the second turnbuckle clamp capscrew.
5. Check for any linkage interference, binding or obstruction in all gears shift positions.

REMOVAL

Rear Linkage

1. Unfasten the rear selector lever from the shift arm and pivot link rod by removing cotter keys and nuts.
2. Loosen both capscrews on the turnbuckle at rear shift linkage and turn off rear shift control rod to remove.

NOTE: Do not disconnect the linkage from the turnbuckle which connects the selector lever to the linkage rear shift rod. This will result in maladjustment of the linkage at reinstallation.

3. Unfasten and remove the pivot link from the transmission mount bracket.

4. Unfasten and remove the shift arm from the inner shift shaft splines.

5. Remove the rear bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

6. Unfasten and remove the rear U-joint and shift rod assembly at its connection with the center tunnel shift tube.

7. Unfasten and remove the flange mounted rear shift tube carrier bearing.

Front Linkage

1. Unfasten the shift lever boot and cover drivers floor and pull shift lever from master shift control box.

NOTE: Shift levers with air control buttons must have master control knob disassembled and removed from shift lever.

2. Unfasten and remove the front U-joint and master shift control box at its connection with the front of first shift rod.

NOTE: Further access for disassembly and remove of the shift linkage requires that the center aisle ramp or the front bogie closing panel and the #1 baggage bay center tunnel closing panels be removed.

3. Unfasten and remove the front tire compartment rear panel plate and boot assembly.

4. Remove either the ramp or front bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

5. Unfasten and remove the U-joint and first shift rod assembly at its connection with the second (ramp) shift rod.

6. Unfasten and remove the flange mounted front shift rod carrier bearing from the front of the second shift rod.

7. Remove the center tunnel cover panel, and disconnect the rest of the U-joint and carrier bearing lube lines.

8. Unfasten and remove the U-joint and second shift rod assembly at its connection with the center tunnel shift tube.

9. Unfasten and remove the flange mounted intermediate shift rod carrier bearing from the front of the shift tube assembly.

NOTE: Shift tube may be removed in pieces by cutting.

INSTALLATION

1. Reassemble and install in reverse order of “Removal” procedure and readjust the linkage.

SPECIFICATIONS

SRC MASTER SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number	13L-7-170

LRC SLAVE SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number (5-Speed T-11605-D)	13J-2-52
Part Number (5-Speed T-11605-F)	13J-2-56
Part Number (7-Speed Without Tone Ring T-14607-A)	13L-2-279
Part Number (7-Speed W/Tone Ring T-14607-A)	13L-2-292
Part Number (7-Speed Without Tone Ring TX-14607-B)	13L-2-280
Part Number (7-Speed W/Tone Ring TX-14607-B)	13L-2-293

SECTION 13B1

AUTOMATIC TRANSMISSION (HT-740D)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	13B1-1
Components	13B1-1
Maintenance	13B1-2
Torque Specifications	13B1-7
Specifications	13B1-8
Service Tools	13B1-8

GENERAL DESCRIPTION

Some 102D series coaches are equipped with the four-speed close-ratio Allison HT-740-D heavy-duty transmission. This transmission features manually shifted range selection, lockup torque converter assembly and a triple planetary gear setup. Additional detailed service procedures for the Allison HT-740-D automatic transmission may be found in the applicable Allison Transmission Service Manuals.

COMPONENTS

TORQUE CONVERTER

The torque converter consists of three elements which are the pump, turbine and stator assemblies. The pump is the input element and is driven directly from the engine. The turbine is the output element and is hydraulically driven by the pump. The stator is a reaction (torque multiplying) element. When the pump turns faster than the turbine, the converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. when this occurs, torque multiplication stops and the converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of three elements which are the piston, clutch plate/damper and a back plate. the piston and back plate are driven by the engine. The clutch plate/damper, located between the piston and the back plate, is splined to the converter turbine.

The lockup clutch is engaged and released in response to electronic commands from the ECU. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The torsional dampening feature absorbs engine vibration.

PLANETARY GEARS & CLUTCHES

A series of three planetary gear sets and shafts provide the gear ratios and direction of travel for the coach. The planetary gear sets are controlled by four multi-plate clutches that work in pairs to produce the four speeds. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate combination of clutch solenoids.

COOLER CIRCUIT

The transmission fluid is cooled by the engine oil cooler. Connections for this cooling circuit are located at the front of the transmission housing to facilitate installation of lines.

SHIFT MODULATOR

An air-actuated transmission shift modulator valve is installed on the HT-740-D automatic transmission when coupled with the 8V-92 (DDEC) electronically controlled engine.

NOTE: A cable-actuated modulator valve is used on non-electronically controlled engine installations.

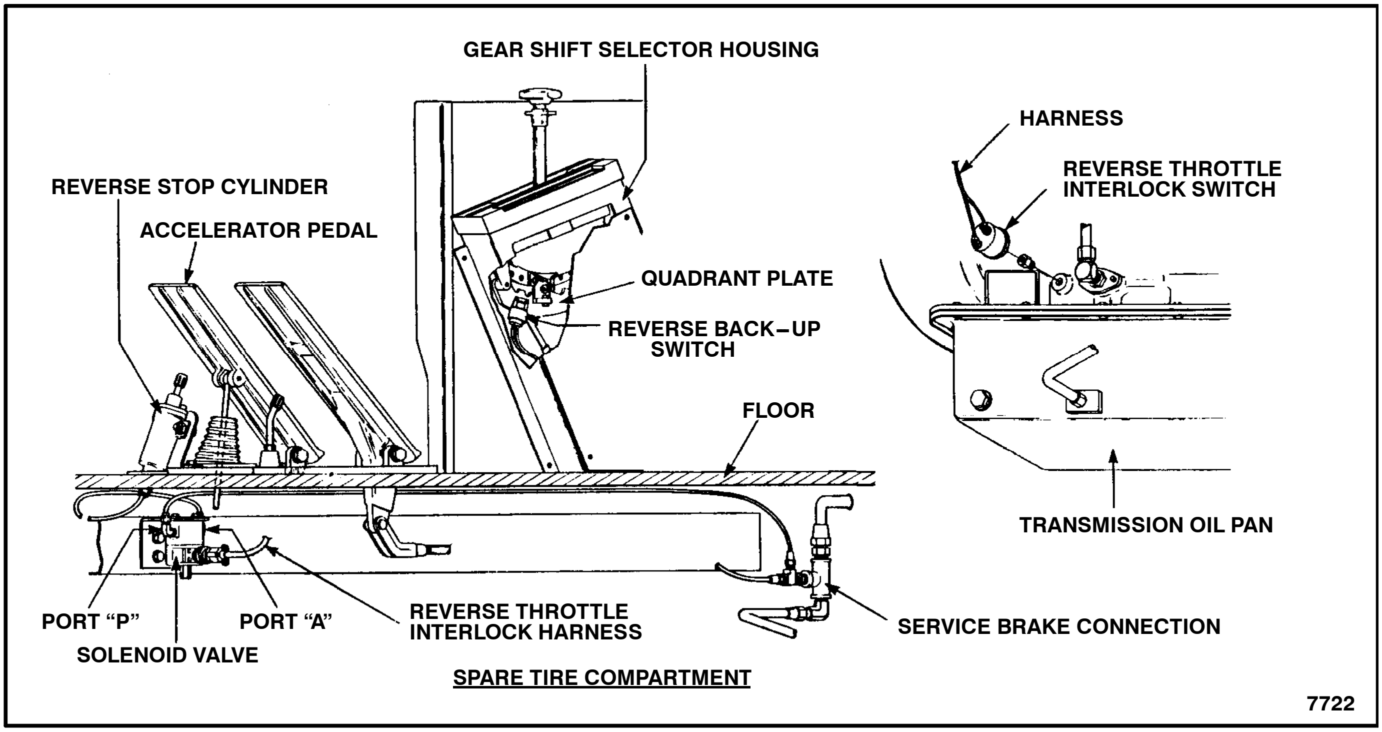

GEAR SHIFT SELECTOR HOUSING
HARNESS
REVERSE THROTTLE INTERLOCK SWITCH
REVERSE STOP CYLINDER
ACCELERATOR PEDAL
QUADRANT PLATE
REVERSE BACK–UP SWITCH
FLOOR
TRANSMISSION OIL PAN
PORT "P"
PORT "A"
REVERSE THROTTLE INTERLOCK HARNESS
SERVICE BRAKE CONNECTION
SOLENOID VALVE
SPARE TIRE COMPARTMENT
7722

Figure 1. Reverse Throttle Interlock Installation

The shift modulator is a single-acting, non-repairable, pneumatic cylinder which provides the transmission shift signal valves with a regulated pressure proportional to the throttle position in order to control the transmission shift function.

Air to operate the modulator valve is supplied from the air manifold which is mounted on the right-hand side of the engine compartment ceiling. A Skinner valve controls the air flow from the manifold to the modulator (Figure 4). The Skinner valve is actuated by signals from the engine's electronic control module.

REVERSE THROTTLE INTERLOCK

In order to avoid drive axle gear damage caused by driver abuse, a reverse throttle interlock is provided for coaches with automatic transmissions (Figure 1). This feature prevents high-speed reverse gear engagement.

Refer to the appropriate wiring diagram in the "Wiring Schematics" located in Section 7J for details of the reverse throttle interlock feature.

SHIFT SELECTOR

The HT-740 four-speed transmission is hydraulically auto-shifted once placed into the desired shift range. The shift range selections are made through the manually operated shift control lever located on the floor console to the right of driver (Figure 2).

MAINTENANCE

PERIODIC INSPECTIONS

Clean and inspect the exterior of the transmission at regular intervals. Severity of the service conditions will determine the frequency of these inspections. Some of the more common inspections would focus on the following conditions:

A. Loose fasteners on the transmission and mounting components.

B. Improper fluid levels or fluid leaks.

C. Damaged or loose cooler hoses.

D. Worn, stretched or improperly routed shift selector cable.

E. Loose, dirty or improperly adjusted transmission modulator assembly.

CONTROL ADJUSTMENTS

Modulator Air Regulator (Electronic Engines)

The Williams air actuated modulators used on all electronically controlled engine installations are non-adjustable. However, the regulator must be set at the correct Skinner valve delivery pressure of 70 psi.

Modulator Linkage (Mechanical Engines)

The mechanically actuated modulator linkage of the non-electronically controlled engines should be properly adjusted for efficient shift performance.

1. Place the fuel control lever of the engine at full throttle position.

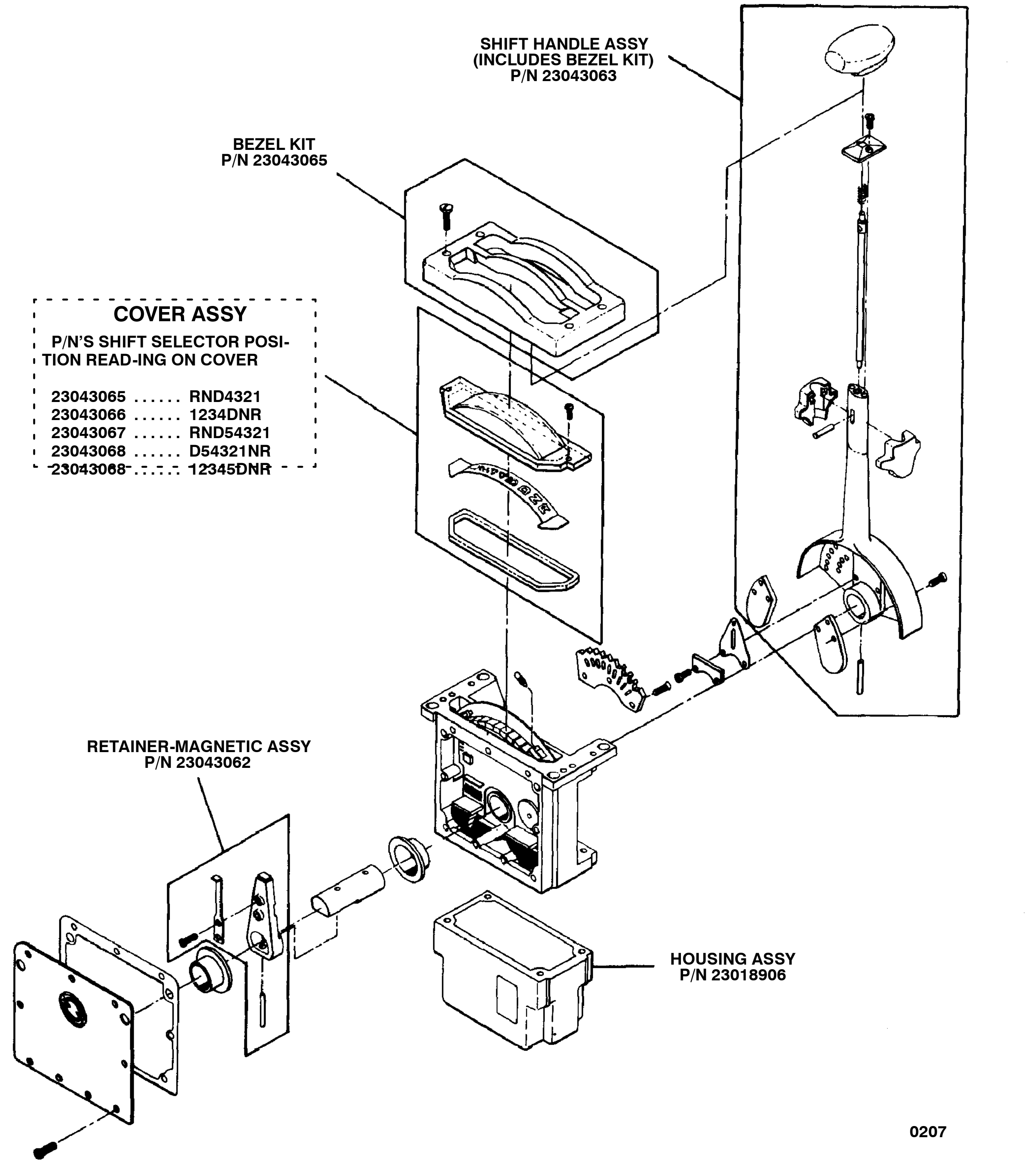

SHIFT HANDLE ASSY
(INCLUDES BEZEL KIT)
P/N 23043063
BEZEL KIT
P/N 23043065
COVER ASSY
P/N'S SHIFT SELECTOR POSI- TION READ-ING ON COVER
23043065 ...... RND4321
23043066 ...... 1234DNR
23043067 ...... RND54321
23043068 ...... D54321NR
~~23043068 ...... 12345DNR~~
RETAINER-MAGNETIC ASSY
P/N 23043062
HOUSING ASSY
P/N 23018906
0207

Figure 2. Shift Selector Repair

2. Place the mechanical actuator cable at full throttle position against the mechanical stop.

3. Adjust the clevis at the fuel control lever so the pin fits freely through the hole in clevis, making sure the lever is secure. Total cable travel should not be less than 1.187 inches (30.14 mm) or more than 1.56 inches (39.62 mm).

Shift Selector Cable

The shift cable has several points of adjustment. An adjustment of approximately 1” can be made at the shift selector lever cable clamp. Another adjustment of 2” may be made at the rear cable mounting bracket.

> **NOTE:** Additional minor cable adjustments can be made at the front rod end and rear pivot ball end. Front and rear rod end turnbuckles must be threaded onto cable at least 1 and 1/2 times the rod diameter.

1. Loosen shift selector cable clamp fasteners and adjust cable to desired position and retighten.

2. Loosen both hex jam nuts on rear cable mounting and adjust cable to desired position and retighten.

LUBRICATION

The transmission fluid cools, lubricates and transmits hydraulic power. Always maintain proper fluid levels. If fluid level is too low, the torque converter and clutches do not receive an adequate supply of fluid and the transmission overheats. If the level is too high, the fluid aerates causing the transmission to shift erratically and overheat. Fluid may be expelled through the breather or dipstick tube when fluid level is too high.

Transmission fluid level should be checked daily first by the manual cold check procedure. Transmission hot fluid level can be checked manually after transmission has reached operating temperature. Check the fluid level using the following procedures and record in a maintenance log.

⚠ WARNING ⚠

When checking the fluid level by the manual method, be sure the transmission is in neutral, the park brake is applied and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

Manual Cold Fluid Level Check

The purpose of the cold check is to determine if the transmission has enough fluid to be operated safely until a hot check can be made. Always check the fluid level reading with the engine running and at least twice.

1. Park vehicle on a level surface.

2. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.

3. Run the engine for at least one minute. apply the service brakes, shift transmission to drive (D) and operate engine at 1000 to 1500 rpm for 30 seconds; then shift to reverse (R) to clear the hydraulic system of air. Finally, shift into neutral (N) and allow the engine to idle (500-800 rpm).

4. With engine still running, remove the dipstick from the tube and wipe clean.

5. Insert the dipstick into tube and remove. Check the level reading.

6. Repeat the check to verify the reading.

7. If the fluid level is within the “COLD RUN” band on the dipstick, the transmission may be operated until the fluid is hot enough to perform a “HOT RUN” check. If the fluid level is not within the limits of the band, add as necessary to bring to the middle of the band.

8. Perform a hot check at the first opportunity after the normal operating temperature is reached.

Manual Hot Fluid Level Check

1. Operate the transmission in drive (D) range until normal operating temperature is reached.

> **NOTE:** Normal operating sump temperature is in the 160-200°F (71-93°C) range. Normal operating converter-out temperature should be in the 180-220°F (82-104°C) range.

2. Park vehicle on a level surface, and allow engine to idle (500-800 rpm).

3. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.

4. Insert the dipstick into tube and remove. Check the level reading.

5. Repeat the check to verify the reading.

6. If the fluid level is not within the limits of the “HOT RUN” band, add as necessary to bring to the middle of the band.

> **NOTE:** Do not allow dirt or foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of internal components.

> **NOTE:** Consistency is important to maintaining accuracy of the reading in a manually checked level. If inconsistent readings persist, check the transmission breather to be sure it is clean and unclogged.

Specification

Hydraulic fluids used in the HT-746 transmissions are important influences on transmission performance, reliability and durability. All lube oil fluids must qualify to Allison's Type C-4 specification if not specifically designated as torque fluids like DEXRON IIE and/or DEXRON III. DEXRON IIE and/or DEXRON III fluids are recommended for most coach automatic transmission service conditions.

The minimum safe operating temperature of DEXRON IIE and/or DEXRON III fluids is -17°F. Sump fluid temperatures below this minimum must be preheated by running equipment with transmission in neutral for approximately 20 minutes before shifting into range operation.

NOTE: Sump temperature must be between 60-120°F (16-49°C) range.

⚠ CAUTION ⚠

Prevent foreign material from entering the transmission by using clean containers, fillers, etc. and by keeping dipstick clean. Containers or fillers that have been used for antifreeze solution or engine coolant must never be used for transmission fluids.

NOTE: Antifreeze and engine coolants contain ethylene glycol. When introduced into transmissions, even small amounts of ethylene glycol can cause clutch plates to fail.

Initial Service Interval

The initial factory fill should be drained and the filters changed after the first 5,000 miles (8,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

Periodic Service Interval

Drain and change the filters every 25,000 miles (40,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.
2. Remove the drain plug from the oil sump pan, and allow the fluid to drain completely.

NOTE: It is not necessary to drain the fluid if only the filters are to be replaced.

3. Remove and discard filter element by turning counter-clockwise (Figure 3).
4. Thoroughly clean any dirt or oil from the base casting.

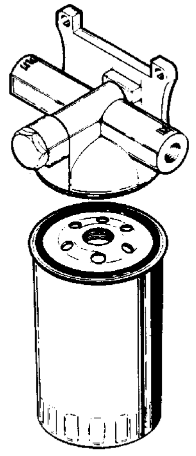


Figure 3. Automatic Transmission Filter

5. Install new element and tighten approximately 2/3 turn beyond first contacts with base.
6. Refill the transmission and check the fluid level using the manual fluid check procedures.

NOTE: The amount of refill fluid will be less than the amount used for the initial factory fill. Fluid should remain in the external cooler circuits, torque converter and transmission cavities after draining. Refer to the capacity schedule in specifications portion of this section for exact fluid quantities used in the HT-746 transmissions.

MODULATOR REPLACEMENT

The cable actuated and air actuated modulators have different "Removal" and "Installation" procedures.

Removal (Air Actuated)

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.
2. Disconnect the modulator air hose from Skinner valve (Figure 4).
3. Unfasten the exterior modulator retainer clip capscrew and remove the modulator from transmission.

Removal (Cable Actuated)

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.
2. Unfasten and remove the modulator actuator cable from engine throttle assembly.
3. Unfasten the exterior modulator retainer clip capscrew and remove the modulator from transmission.

Installation (Air Actuated)

1. Remove protective covers from transmission and/or modulator valve.

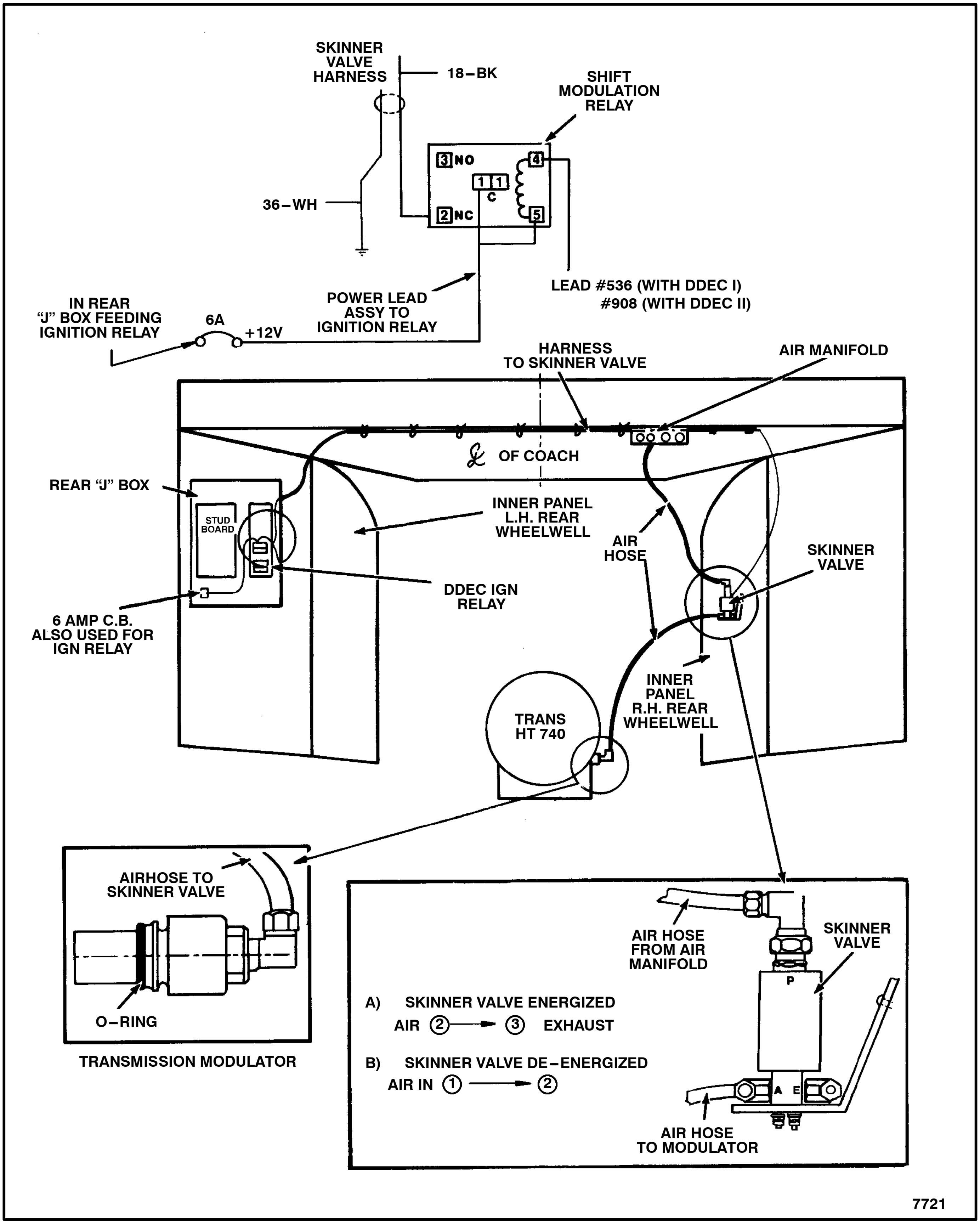

SKINNER VALVE HARNESS
18-BK
SHIFT MODULATION RELAY
3 NO
1 1
C
4
2 NC
5
36-WH
POWER LEAD ASSY TO IGNITION RELAY
LEAD #536 (WITH DDEC I)
#908 (WITH DDEC II)
IN REAR "J" BOX FEEDING IGNITION RELAY
6A
+12V
HARNESS TO SKINNER VALVE
AIR MANIFOLD
℄ OF COACH
REAR "J" BOX
STUD BOARD
INNER PANEL L.H. REAR WHEELWELL
AIR HOSE
SKINNER VALVE
DDEC IGN RELAY
6 AMP C.B. ALSO USED FOR IGN RELAY
INNER PANEL R.H. REAR WHEELWELL
TRANS HT 740
AIRHOSE TO SKINNER VALVE
O-RING
TRANSMISSION MODULATOR
AIR HOSE FROM AIR MANIFOLD
SKINNER VALVE
P
A) SKINNER VALVE ENERGIZED
AIR ② → ③ EXHAUST
B) SKINNER VALVE DE-ENERGIZED
AIR IN ① → ②
A E
AIR HOSE TO MODULATOR
7721

Figure 4. Modulator Installation (DDEC Engines)

NOTE: If applicable, make certain modulator valve spacer pin is in place (supplied with transmission). Ensure that the O-ring is in place on the modulator valve.

2. Lubricate shaft with transmission fluid, and Insert modulator valve into transmission.

3. Place retaining clip in groove on valve housing and torque capscrew to 15-20 ft-lbs (20-27 N·m) torque.

Installation (Cable Actuated)

1. Follow steps 1 thru 3 of previous procedure.
2. Route cable and secure to pivot arm on governor.
3. Rotate the governor pivot lever to the full throttle position.
4. Pull the cable until it is internally bottomed. Adjust trunnion on end of cable to permit a "free pin" with fuel control lever in full fuel position. Install and secure pin.
5. Check linkage for proper return to idle position, and check adjustment with the previous "Adjustment" procedure.

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 9 of this removal procedure. A transmission dolly is available through parts outlets or may be fabricated. See "Service Tools" at end of this section.

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.
2. Drain the fluid from the transmission, and remove the dipstick and tube.
3. Disconnect all electrical harnesses from the transmission.
4. Disconnect the modulator actuator cable or air line from the transmission.
5. Disconnect the shift control cable from the transmission shift lever.
6. Disconnect any remote oil filter lines at the transmission.
7. Disconnect the driveshaft from the transmission. Refer to the "Driveshaft Removal" procedure in section 14.
8. Remove the engine and transmission module as an assembly. Refer to the "Engine Removal" procedure shown in section 8A1 thru 8A4.
9. Support the rear of the engine with jack stands, and unfasten and remove the mounts and brackets attaching the transmission to the engine cradle.
10. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ **CAUTION** ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent torque converter and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the torque converter. Failure to observe this caution will result in damage to the transmission and/or torque converter.

NOTE: Inspect the engine-to-transmission mounting surfaces and flex plates for any signs of wear or damage.

INSTALLATION

1. Install the transmission in reverse order of the "Removal" procedure.

TORQUE SPECIFICATIONS

Transmission Hydraulic Line Fittings	40-50 ft-lbs (53-66 N·m)
Transmission Mounting Bracket Capscrews	168-196 ft-lbs (227-265 N·m)
Transmission Flange Mounting Capscrews	40-50 ft-lbs (53-66 N·m)
Transmission Flange Mounting Capscrews (Cummins)	54-65 ft-lbs (72-86 N·m)
Flexplate-to-Converter Mounting Capscrews (1/2"-20)	95-115 ft-lbs (126-153 N·m)
Flexplate-to-Converter Mounting Capscrews (3/8"-24)	41-49 ft-lbs (54-65 N·m)

SPECIFICATIONS

TRANSMISSION ASSEMBLY - HT-741

Manufacturer	Allison
Part Number (W/498 Series Torque Converter & Series 60)	13L-1-139
Part Number (W/Tone Ring, 498 Series Torque Converter & Series 60)	13L-1-163
Part Number (W/497 Series Torque Converter)	13L-1-159
Part Number (W/496 Series Torque Converter)	13L-1-161
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-126
Part Number (W/Tone Ring, 496 Series Torque Converter & Series 60)	13L-1-162
Part Number (W/496 Series Torque Converter & Cummins)	13L-1-172
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-164
Part Number (W/495 Series Torque Converter)	13L-1-160

COOLER ASSEMBLY

Manufacturer	Allison
Part Number (Series 60 Installations)	6L-8-528
Part Number (Cummins & Caterpillar Installations)	6K-8-48

FILTER ASSEMBLY

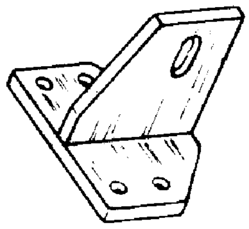
Manufacturer	A.C. Delco
Part Number	13G-10-24
Part Number (Element)	13G-10-26

CAPACITY SCHEDULE

HT-740D	Initial Factory Fill: 44 Qts. (41.5 L) *Note: Capacities are approximate only. Please check dipstick levels with the proper "Fluid Level Check" procedure.*	Service Fill: 37 Qts. (35 L) *Note: Capacities shown are for 4-1/2" deep oil pan.*

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IT THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



Lifting Lug - P/N 20-57

SECTION 13B2

AUTOMATIC TRANSMISSION (HT-741, HT-746 & HT-755)

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Specifications 13B2-6

GENERAL DESCRIPTION

The 102D series coaches may be equipped with the Allison HT-741 or HT-746 four-speed transmission, or the Allison HT-755 five-speed transmission. These transmissions are all close-ratio heavy-duty electronic control transmissions. These transmissions feature remote mounted oil cooler assemblies, lockup torque converter assembly, triple planetary gear setup and (ATEC) Electronic Control System. Additional detailed service procedures for all Allison HT-700 series automatic transmissions may be found in the applicable Allison Transmission Service Manuals.

COMPONENTS

ATEC ELECTRONIC CONTROL SYSTEM

The ATEC Electronic Control System consists of five major components connected by wiring harness. These components are the Electronic Control Unit (ECM), engine throttle position sensor (or direct electronic communication as provided by the electronic accelerator pedal), speed sensor, shift selector and the transmission's internal control module (which contains the solenoid valves and pressure switch). For more information on the ATEC system, refer to section 13B6.

The throttle position sensor, speed sensor, pressure switch, and shift selector transmit information to the ECU. The ECU processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

TORQUE CONVERTER

The torque converter consists of three elements which are the pump, turbine and stator assemblies. The pump is the input element and is driven directly from the engine. The turbine is the output element and is hydraulically driven by the pump.

The stator is a reaction (torque multiplying) element. When the pump turns faster than the turbine, the converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. when this occurs, torque multiplication stops and the converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of three elements which are the piston, clutch plate/damper and a back plate. the piston and back plate are driven by the engine. The clutch plate/damper, located between the piston and the back plate, is splined to the converter turbine.

The lockup clutch is engaged and released in response to electronic commands from the ECU. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The torsional dampening feature absorbs engine vibration.

PLANETARY GEARS & CLUTCHES

A series of three planetary gear sets and shafts provide the gear ratios and direction of travel for the coach. The planetary gear sets are controlled by four multi-plate clutches that work in pairs to produce the five speeds. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate combination of clutch solenoids.

COOLER CIRCUIT

The transmission fluid is cooled by a remote-mounted fluid cooler. Connections for this cooling circuit are located at the front of the transmission to facilitate installation of remote cooler lines.

SHIFT SELECTOR (ATEC)

The electronically controlled hydraulic auto-shifting of the HT-700 series four and five-speed (ATEC) transmissions are totally automatic. The shift range selections are made through a touch-pad module shift selector control located on the floor console to the right of the driver (Figures 1 & 2).

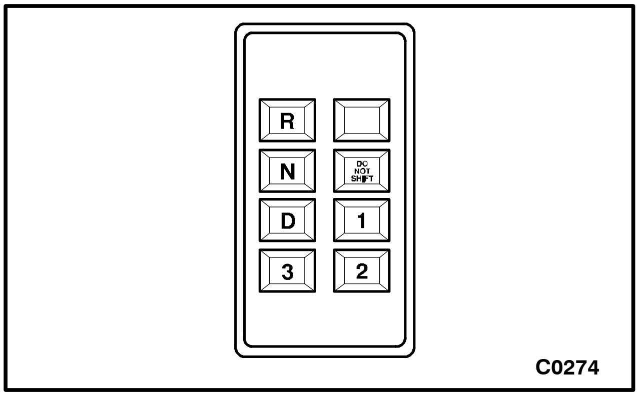


Figure 1. Four Speed Shift Selector

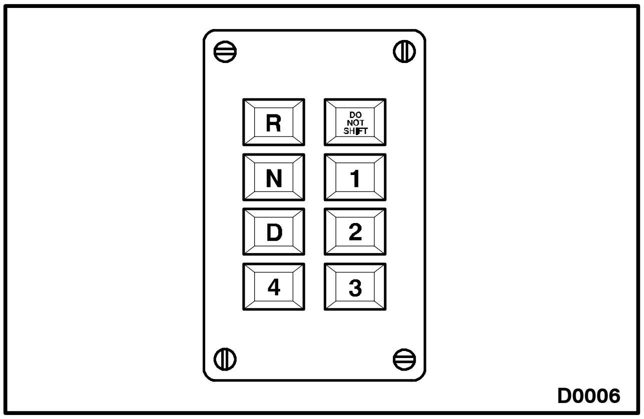


Figure 2. Five Speed Shift Selector

MAINTENANCE

PERIODIC INSPECTIONS

Clean and inspect the exterior of the transmission at regular intervals. Severity of the service conditions will determine the frequency of these inspections. Some of the more common inspections would focus on the following conditions:

A. Loose fasteners on the transmission and mounting components.

B. Improper fluid levels or fluid leaks.

C. Damaged or loose cooler hoses.

D. Worn or improperly routed electrical harnesses.

E. Loose, dirty, or improperly adjusted electronic throttle sensor.

LUBRICATION

The transmission fluid cools, lubricates and transmits hydraulic power. Always maintain proper fluid levels. If fluid level is too low, the torque converter and clutches do not receive an adequate supply of fluid and the transmission overheats. If the level is too high, the fluid aerates causing the transmission to shift erratically and overheat. Fluid may be expelled through the breather or dipstick tube when fluid level is too high.

Transmission fluid level should be checked daily with the manual cold check procedure. Transmission hot fluid level can be manually checked only after normal operating temperature has been attained. Check the fluid level using the following procedures and record in a maintenance log.

⚠ WARNING ⚠

When checking the fluid level by the manual method, be sure the transmission is in neutral, the park brake is applied and the wheels are

chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

Manual Cold Fluid Level Check

The purpose of the cold check is to determine if the transmission has enough fluid to be operated safely until a hot check can be made. Always check the fluid level reading with the engine running and at least twice.

1. Park vehicle on a level surface.
2. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.
3. Run the engine for at least one minute. apply the service brakes, shift transmission to drive (D) and operate engine at 1000 to 1500 rpm for 30 seconds; then shift to reverse (R) to clear the hydraulic system of air. Finally, shift into neutral (N) and allow the engine to idle (500-800 rpm).
4. With engine still running, remove the dipstick from the tube and wipe clean.
5. Insert the dipstick into tube and remove. Check the level reading.
6. Repeat the check to verify the reading.
7. If the fluid level is within the “COLD RUN” band on the dipstick, the transmission may be operated until the fluid is hot enough to perform a “HOT RUN” check. If the fluid level is not within the limits of the band, add as necessary to bring to the middle of the band.
8. Perform a hot check at the first opportunity after the normal operating temperature is reached.

Manual Hot Fluid Level Check

1. Operate the transmission in drive (D) range until normal operating temperature is reached.

NOTE: Normal operating sump temperature is in the 160-200°F (71-93°C) range. Normal operating converter-out temperature should be in the 180-220°F (82-104°C) range.

2. Park vehicle on a level surface, and allow engine to idle (500-800 rpm).
3. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.
4. Insert the dipstick into tube and remove. Check the level reading.
5. Repeat the check to verify the reading.
6. If the fluid level is not within the limits of the “HOT RUN” band, add as necessary to bring to the middle of the band.

NOTE: Do not allow dirt or foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of internal components.

NOTE: Consistency is important to maintaining accuracy of the reading in a manually checked level. If inconsistent readings persist, check the transmission breather to be sure it is clean and unclogged.

Specification

Hydraulic fluids used in the HT-746 transmissions are important influences on transmission performance, reliability and durability. All lube oil fluids must qualify to Allison’s Type C-4 specification if not specifically designated as torque fluids like DEXRON IIE and/or DEXRON III. DEXRON IIE and/or DEXRON III fluids are recommended for most coach automatic transmission service conditions.

The minimum safe operating temperature of DEXRON IIE and/or DEXRON III fluids is -17°F. Sump fluid temperatures below this minimum must be preheated by running equipment with transmission in neutral for approximately 20 minutes before shifting into range operation.

NOTE: Sump temperature must be between 60-120°F (16-49°C) range.

⚠ CAUTION ⚠

Prevent foreign material from entering the transmission by using clean containers, fillers, etc. and by keeping dipstick clean. Containers or fillers that have been used for antifreeze solution or engine coolant must never be used for transmission fluids.

NOTE: Antifreeze and engine coolants contain ethylene glycol. When introduced into transmissions, even small amounts of ethylene glycol can cause clutch plates to fail.

Initial Service Interval

The initial factory fill should be drained and the filters changed after the first 5,000 miles (8,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

Periodic Service Interval

Drain and change the filters every 25,000 miles (40,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or

DEXRON III) as shown in Section 10 of this manual.

1. Turn Master Switch off, and block front and rear wheels.

2. Remove the drain plug from the oil sump pan, and allow the fluid to drain completely.

NOTE: It is not necessary to drain the fluid if only the filters are to be replaced.

3. Remove filter element by rotating counter clockwise (Figure 3).

4. Discard element.

5. Thoroughly clean any dirt or oil from the base casting.

6. Install new element. Tighten element ⅔ turn after element seal first contacts the base.

7. Refill the transmission and check the fluid level using the manual fluid check procedures.

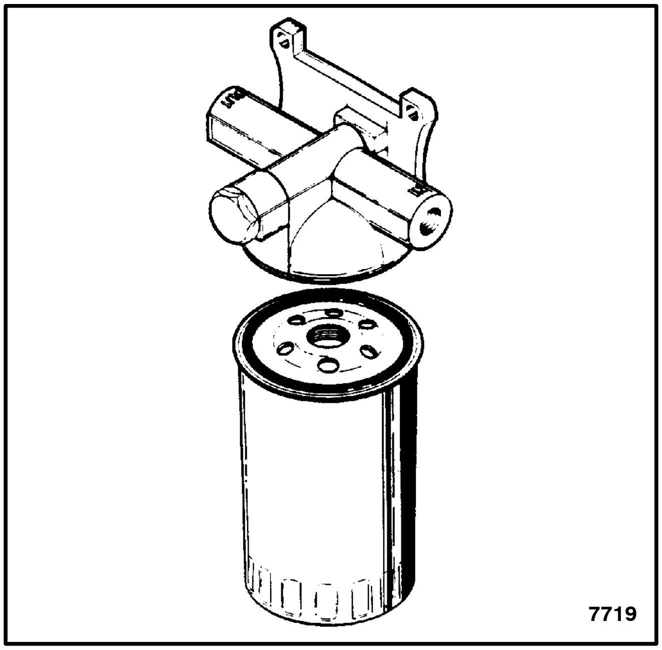


Figure 3. Automatic Transmission Filter

NOTE: The amount of refill fluid will be less than the amount used for the initial factory fill. Fluid should remain in the external cooler circuits, torque converter and transmission cavities after draining. Refer to the capacity schedule in specifications portion of this section for exact fluid quantities used in the HT-755 transmissions.

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 8 of this removal procedure. A transmission dolly is available through parts outlets or may be fabricated. See "Service Tools" at end of this section.

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.

2. Drain the fluid from the transmission, and remove the dipstick and tube.

3. Disconnect all electrical harnesses from the transmission.

4. Disconnect and remove the remote cooler and oil filter assemblies and their associated mounting brackets and lines from the transmission.

5. Disconnect the driveshaft from the transmission. Refer to the "Driveshaft Removal" procedure in section 14.

6. Remove the engine and transmission module as an assembly. Refer to the "Engine Removal" procedure shown in section 8A1 thru 8A4.

7. Support the rear of the engine with jack stands, and unfasten and remove the mounts and brackets attaching the transmission to the engine cradle.

8. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ CAUTION ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent torque converter and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the torque converter. Failure to observe this caution will result in damage to the transmission and/or torque converter.

NOTE: Inspect the engine-to-transmission mounting surfaces and flex plates for any signs of wear or damage.

INSTALLATION

1. Install the transmission in reverse order of the "Removal" procedure.

SPECIFICATIONS

TRANSMISSION ASSEMBLY - HT-741

Manufacturer	Allison
Part Number (W/498 Series Torque Converter & Series 60)	13L-1-184
Part Number (W/497 Series Torque Converter)	13K-1-121
Part Number (W/496 Series Torque Converter)	13K-1-118
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-127
Part Number (W/496 Series Torque Converter & Cummins)	13L-1-177
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-140
Part Number (W/495 Series Torque Converter)	13K-1-120

TRANSMISSION ASSEMBLY - HT-746

Manufacturer	Allison
Part Number (W/497 Series Torque Converter & Cummins)	13K-1-115
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-116
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-117
Part Number (W/495 Series Torque Converter & Cummins)	13L-1-7
Part Number (W/495 Series Torque Converter & Caterpillar)	13L-1-467

TRANSMISSION ASSEMBLY - HT-755

Manufacturer	Allison
Part Number (W/498 Series Torque Converter & Series 60)	13L-1-185
Part Number (W/497 Series Torque Converter)	13K-1-123
Part Number (W/496 Series Torque Converter)	13K-1-119
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-127
Part Number (W/496 Series Torque Converter & Cummins)	13L-1-178
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-173
Part Number (W/495 Series Torque Converter)	13K-1-122

COOLER ASSEMBLY

Manufacturer	Allison
Part Number (Series 60 Installations)	6L-8-528
Part Number (Cummins & Caterpillar Installations)	6K-8-48

FILTER ASSEMBLY

Manufacturer	A.C. Delco
Part Number	13G-10-24
Part Number (Element)	13G-10-26

TORQUE SPECIFICATIONS

Transmission Hydraulic Line Fittings	40-50 ft-lbs. (53-66 N·m)
Transmission Mounting Bracket Capscrews	168-196 ft-lbs. (227-265 N·m)
Transmission Mounting Capscrews	40-50 ft-lbs. (53-66 N·m)
Transmission Mounting Capscrews (Cummins)	54-65 ft-lbs. (72-86 N·m)
Flexplate-to-Converter Mounting Capscrews (1/2”-20)	95-115 ft-lbs. (126-153 N·m)
Flexplate-to-Converter Mounting Capscrews (3/8”-24)	41-49 ft-lbs. (54-65 N·m)

CAPACITY SCHEDULE

HT-741	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 34 Qts. (32. L)
HT-746	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 34 Qts. (32. L)
HT-755	Initial Factory Fill: 44 Qts. (41.5 L)	Service Fill: 34 Qts. (32 L)
	Note: Capacities are approximate only. Please check dipstick levels with the proper "Fluid Level Check" procedure.	*Note: Capacities shown are for 4-1/2" deep oil pans.*

SECTION 13B3

AUTOMATIC TRANSMISSION (B-500, B-500R, HT-4060 & HT-4060R)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	13B3-1
Components	13B3-1
Maintenance	13B3-2
Miscellaneous Torque Specifications	13B3-6
Specifications	13B3-6

GENERAL DESCRIPTION

Some 102D series coaches may be equipped with the Allison B-500 or B-500R five-speed (WT) transmission. The 102DLS3 model conversion coaches are equipped with the Allison HD-4060 or HD-4060R five-speed (WT) transmissions. These transmissions are close-ratio, heavy-duty, electronically controlled transmissions.

NOTE: The HT-4060 series (WT) transmissions are designed for lighter duty operational cycles.

The transmission installations typically feature a remote mounted oil cooler assembly, the (WT) Electronic Control System, lockup torque converter assembly with torsion dampening and a triple planetary gear setup.

Other unique features of the B-500 and HD-4060 series transmissions are internal filtration systems and combination control module and sump cover assemblies. Coaches equipped with the B-500R and HT-4060 transmissions additionally incorporate an output retarder assembly and an accumulator circuit.

Detailed service procedures for the Allison B-500, B-500R, HT-4060 and HT-4060R (WT) automatic transmissions may be found in the applicable Allison Transmission Service Manuals.

COMPONENTS

ELECTRONIC CONTROL SYSTEM

The (WT) Electronic Control System consists of five major components connected by wiring harness. These components are the Electronic Control Unit (ECU), engine throttle position sensor (or direct electronic communication as provided by the electronic accelerator pedal), three speed sensors, shift selector, and control module (which contains the solenoid valves and pressure switch).

The throttle position sensor, speed sensors, pressure switch, and shift selector transmit information to the ECU. The ECU processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

A feature of the WT control system has the ability to adapt or “learn” as it operates. Each shift is electronically measured, stored, and used by the ECU to adapt to the optimum conditions for future clutch application and release.

Note: It is important to note, that if the shift quality of a low-mileage coach or coach with a new or recalibrated ECU is unacceptable, simply drive the coach through its normal shift ranges a few times. After a short learning period, any rough shifting should be corrected and shift quality restored.

TORQUE CONVERTER

The torque converter consists of three elements which are the pump, turbine and stator assemblies. The pump is the input element and is driven directly from the engine. The turbine is the output element and is hydraulically driven by the pump.

The stator is a reaction (torque multiplying) element. When the pump turns faster than the turbine, the converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. when this occurs, torque multiplication stops and the converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of three elements which are the piston, clutch plate/damper and a back plate. the piston and back plate are driven by the engine. The clutch plate/damper, located between the piston and the back plate, is splined to the converter turbine. The lockup clutch is engaged and released in response to electronic commands from the ECU. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The torsional dampening feature absorbs engine vibration.

PLANETARY GEARS & CLUTCHES

A series of three planetary gear sets and shafts provide the gear ratios and direction of travel for the coach. The planetary gear sets are controlled by five multi-plate clutches that work in pairs to produce the four speeds. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate combination of clutch solenoids.

RETARDER

The self-contained retarder assembly of the B-500R and HT-4060R transmissions are located at the rear output area and consists of a vaned rotor which rotates in a vaned cavity. When the retarder is applied, a control valve instantly releases fluid to fill the retarder cavity. The rotating element acts to quickly slow the coach.

COOLER CIRCUIT

The transmission fluid is cooled by a remote-mounted fluid cooler. Connections for this cooling circuit are located at the rear of the transmission to facilitate installation of remote cooler lines.

Additionally, all B-500R retarder transmissions are equipped with a separate accumulator/cooler assembly for cooling of fluid used by the retarder while in operation, and as a storage reservoir for the fluid while retarder is not in use.

SHIFT SELECTOR (WT CONTROL)

The electronically controlled hydraulic auto-shifting of the B-500 and B-500R five-speed WT transmissions are totally automatic. The shift range selections are made through either touch-pad modules or T-handled shift selector controls located on the floor console to the right of driver (Figure 1).

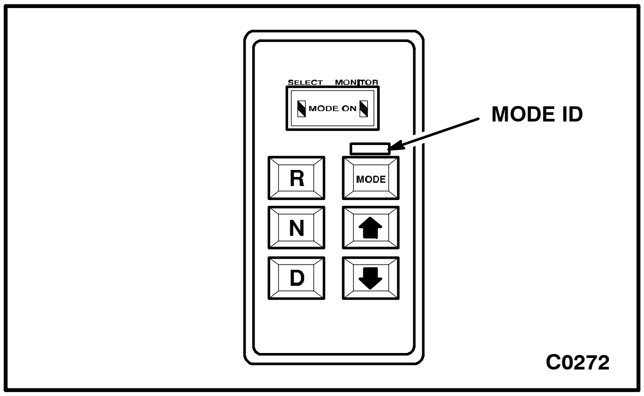


Figure 1. Shift Selector

NOTE: The transmission incorporates a hold feature to prohibit upshifting above the range selected during normal driving. For downhill operation, however, the transmission may upshift above the highest selected range when engine governed speed is exceeded and damaging engine over-speed is a possibility.

MAINTENANCE

PERIODIC INSPECTIONS

Clean and inspect the exterior of the transmission at regular intervals. Severity of the service conditions will determine the frequency of these inspections. Some of the more common inspections would focus on the following conditions:

A. Loose fasteners on the transmission and mounting components.

B. Improper fluid levels or fluid leaks.

C. Damaged or loose cooler hoses.

D. Worn or improperly routed electrical harnesses.

E. Loose, dirty, or improperly adjusted electronic throttle sensor.

LUBRICATION

The transmission fluid cools, lubricates and transmits hydraulic power. Always maintain proper fluid levels. If fluid level is too low, the torque converter and clutches do not receive an adequate supply of fluid and the transmission overheats. If the level is too high, the fluid aerates causing the transmission to shift erratically and overheat. Fluid may be expelled through the breather or dipstick tube when fluid level is too high.

Transmission fluid level should be checked daily with the manual cold check procedure. Transmission hot fluid level can be checked manually or electronically. Check the fluid level using the following procedures and record in a maintenance log.

⚠ WARNING ⚠

When checking the fluid level by the manual method, be sure the transmission is in neutral, the park brake is applied and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

Manual Cold Fluid Level Check

The purpose of the cold check is to determine if the transmission has enough fluid to be operated safely until a hot check can be made. Always check the fluid level reading with the engine running and at least twice.

1. Park vehicle on a level surface.
2. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.
3. Run the engine for at least one minute. apply the service brakes, shift transmission to drive (D) and operate engine at 1000 to 1500 rpm for 30 seconds; then shift to reverse (R) to clear the hydraulic system of air. Finally, shift into neutral (N) and allow the engine to idle (500-800 rpm).
4. With engine still running, remove the dipstick from the tube and wipe clean.
5. Insert the dipstick into tube and remove. Check the level reading.
6. Repeat the check to verify the reading.
7. If the fluid level is within the “COLD RUN” band on the dipstick, the transmission may be operated until the fluid is hot enough to perform a “HOT RUN” check. If the fluid level is not within the limits of the band, add as necessary to bring to the middle of the band.
8. Perform a hot check at the first opportunity after the normal operating temperature is reached.

Manual Hot Fluid Level Check

1. Operate the transmission in drive (D) range until normal operating temperature is reached.

NOTE: Normal operating sump temperature is in the 160-200°F (71-93°C) range. Normal operating converter-out temperature should be in the 180-220°F (82-104°C) range.

2. Park vehicle on a level surface, and allow engine to idle (500-800 rpm).
3. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.
4. Insert the dipstick into tube and remove. Check the level reading.
5. Repeat the check to verify the reading.
6. If the fluid level is not within the limits of the “HOT RUN” band, add as necessary to bring to the middle of the band.

NOTE: Do not allow dirt or foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of internal components.

NOTE: Consistency is important to maintaining accuracy of the reading in a manually checked level. If inconsistent readings persist, check the transmission breather to be sure it is clean and unclogged.

Electronic Fluid Check

1. After reaching the normal operating temperature, park vehicle on a level surface and allow engine to idle (500-800 rpm).
2. On pushbutton shift selectors, simultaneously press the ▲ “UP” and ▼ “DOWN” arrow buttons once. On lever shift selectors, press the “DISPLAY MODE” button once.

NOTE: The oil level sensor’s temperature range is from 140-220°F (60-104°C).

The ECU may delay the fluid level check until the following conditions are met:

A. Transmission fluid temperature is above 140°F or below 220°F.

B. The transmission is in neutral (N).

C. The vehicle has been stationary for five minutes to allow the fluid to settle.

D. The engine is at idle speed.

The delayed fluid level display signal is a flashing indicator under the SELECT display and a countdown from 8 to 1 under the MONITOR display.

3. A correct fluid level is reported when an “OL” is displayed (“OL” indicates the Oil Level Check Mode), followed by “OK”. The “OK” display indicates that the fluid level is within an acceptable zone.

Example: “OL OK” indicates correct fluid level.

NOTE: The dipstick check may not agree exactly with sensor checks, because the oil level sensor compensates for fluid temperatures.

4. Low fluid level is reported when an “OL” is displayed, followed by “LO” and a number. “LO” indicates a low fluid level, and the number indicates

quarts of fluid the transmission requires.

Example: “OL LO 02” indicates that two additional quarts of fluid should bring the level to the acceptable zone.

NOTE: Confirm an electronically obtained low fluid condition by making a manual fluid level check.

5. High fluid level is reported when an “OL” is displayed, followed by “HI” and a number. “HI” indicates a high fluid level, and the number indicates quarts overfilled.

Example: “OL HI 01” indicates one quart past the full level.

⚠ CAUTION ⚠

A low or high fluid level causes overheating and irregular shift patterns. If not corrected, this condition can damage the transmission.

6. Invalid Display conditions are reported when an “OL” is displayed, followed by “--” and a number. The displayed number is a code, and would indicate an improper condition for electronic check or a system malfunction.

Example: “OL -- 70” would indicate that the oil sump temperature is too low.

NOTE: The Invalid Display is activated when conditions do not allow the fluid level to be checked. Review the following codes and their associated conditions to assist in quickly correcting the condition.

CODES	DESCRIPTIONS
“OL -- 50”	- Engine speed (rpm) too low.
“OL -- 59”	- Engine speed (rpm) too high.
“OL -- 65”	- Neutral (N) must be selected.
“OL -- 70”	- Sump oil temperature too low.
“OL -- 79”	- Sump oil temperature too high.
“OL -- 89”	- Output shaft rotation.
“OL -- 95”	- Sensor failure.

7. To exit the oil level display mode with pushbutton shift selector, press any other button on selector. To exit the oil level display mode with lever shift selector, press the DISPLAY MODE pushbutton one time.

Specification

Hydraulic fluids used in the B-500 and B-500R transmissions are important influences on transmission performance, reliability and durability. All lube oil fluids must qualify to Allison’s Type C-4 specification, if not specifically designated as torque fluids like DEXRON IIE and/or DEXRON III. DEXRON IIE and/or DEXRON III fluids are recommended for most coach automatic transmission service conditions.

The minimum safe operating temperature of DEXRON IIE and/or DEXRON III fluids is -17°F. Sump fluid temperatures below this minimum must be preheated by running equipment with transmission in neutral for approximately 20 minutes before shifting into range operation.

⚠ CAUTION ⚠

Prevent foreign material from entering the transmission by using clean containers, fillers, etc. and by keeping dipstick clean. Containers or fillers that have been used for antifreeze solution or engine coolant must never be used for transmission fluids.

NOTE: Antifreeze and engine coolants contain ethylene glycol. When introduced into transmissions, even small amounts of ethylene glycol can cause clutch plates to fail.

Initial Service Interval

The initial factory fill should be drained and the filters changed after the first 5,000 miles (8,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

Periodic Service Interval

Drain and change the filters every 25,000 miles (40,000 km) or 18 months, whichever occurs first. Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

The B-500 and B-500R WT transmissions incorporate twin internal (sump mounted) filters. The filter assemblies are removed from the bottom (Figure 2).

Filter Removal

1. Turn Master Switch off, and block front and rear wheels.

2. Remove the drain plug from the control module sump, and allow the fluid to drain completely.

NOTE: It is not necessary to drain the fluid if only the filters are to be replaced. The control module and sump are in assembly with each other.

3. Unfasten and remove the twelve capscrews from both filter covers.

4. Remove the cover, O-ring, gasket and filter element from the bottom of the control module.

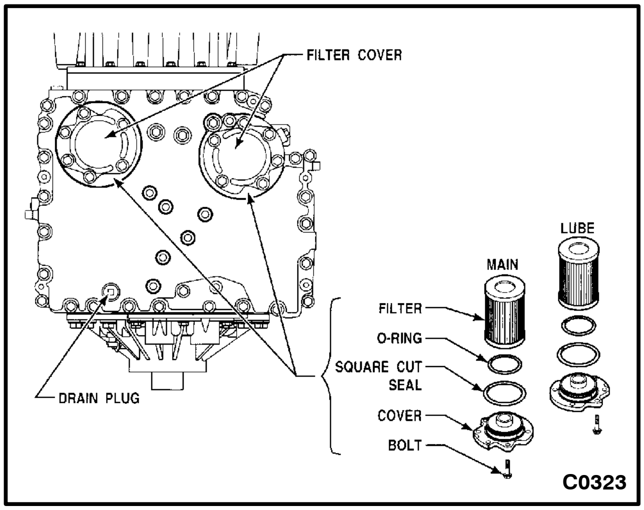


Figure 2. Internal Filters

Filter Installation

1. Pre-lube and install an O-ring on each filter element assembly.

2. Install the gasket seal on each cover, then join filter elements onto cover assemblies.

3. Install filter and cover assemblies into the filter compartments of the control module. Align each filter/cover assembly with the holes in the channel plate/sump. Push the cover assemblies in by hand to seat the seals.

⚠ CAUTION ⚠

Do not use the bolts to draw filter covers to the sump. This can damage the covers, seals and/or sump.

4. Install capscrews into each cover and tighten to 38-45 ft-lbs (51-61 N·m).

5. Inspect drain plug O-ring and reinstall into control module sump. Tighten plug to 18-24 ft-lbs (25-32 N·m).

6. Refill the transmission and check the fluid level using the manual fluid check procedures.

NOTE: The amount of refill fluid will be less than the amount used for the initial factory fill. Fluid should remain in the external cooler circuits, torque converter and transmission cavities after draining. Refer to the capacity schedule in specifications portion of this section for exact fluid quantities used in the B-500 and B-500R transmissions.

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 8 of this removal procedure. A transmission dolly is available through parts outlets or may be fabricated. See “Service Tools” at end of this section.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Drain the fluid from the transmission, and remove the dipstick and fill tube.

3. Disconnect all electrical harnesses and retarder air lines from the transmission.

4. Disconnect and remove the remote cooler, retarder accumulator and oil filter assemblies with their associated mounting brackets, lube and coolant lines from the transmission.

5. Disconnect the driveshaft from the transmission. Refer to the “Driveshaft Removal” procedure in section 14.

6. Remove the engine and transmission module as an assembly. Refer to the “Engine Removal” procedure shown in section 8A1 thru 8A4.

7. Support the rear of the engine with jack stands, and unfasten and remove the mounts and brackets attaching the transmission to the engine cradle.

8. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ CAUTION ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent torque converter and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the torque converter. Failure to observe this caution will result in damage to the transmission and/or torque converter.

NOTE: Inspect the engine-to-transmission mounting surfaces and flex plates for any signs of wear or damage.

INSTALLATION

1. Install the transmission in reverse order of the “Removal” procedure.

MISCELLANEOUS TORQUE SPECIFICATIONS

Transmission Hydraulic Line Fittings	40-50 ft-lbs (53-66 N·m)
Transmission Flange Mounting Capscrews (7/16”-14)	40-50 ft-lbs (53-66 N·m)
Transmission Mounting Bracket Capscrews	168-196 ft-lbs (227-265 N·m)
Flexplate-to-Crankshaft Mounting Capscrews	50 ft-lbs plus 120 degrees (66 N·m)
Flexplate-to-Converter Mounting Capscrews	17-21 ft-lbs (23-28 N·m)

SPECIFICATIONS

TRANSMISSION ASSEMBLY - B500

Manufacturer	Allison
Part Number (W/Version 6 Electronics)	13L-1-189
Part Number (W/Version 7 Electronics)	13L-1-202
Part Number (W/Version 6 Electronics & Retarder)	13L-1-190
Part Number (W/Version 7 Electronics & Retarder)	13L-1-200

TRANSMISSION ASSEMBLY - HD-4060

Manufacturer	Allison
Part Number (W/Version 6 Electronics)	13L-1-197
Part Number (W/Version 7 Electronics)	13L-1-205
Part Number (W/Version 6 Electronics & Retarder)	13L-1-193
Part Number (W/Version 7 Electronics & Retarder)	13L-1-204

COOLER ASSEMBLY

Manufacturer	Allison
Part Number	13L-10-174
Part Number (Retarder Installations)	13L-10-173

ACCUMULATOR ASSEMBLY

Manufacturer	Allison
Part Number	13L-2-115

CAPACITY SCHEDULE

B-500	Initial Factory Fill: 32 Qts. (30 L)	Service Fill: 25 Qts. (23 L)
B-500R	Initial Factory Fill: 40 Qts. (38 L)	Service Fill: 25 Qts. (23 L)
HD-4060	Initial Factory Fill: 32 Qts. (30 L)	Service Fill: 25 Qts. (23 L)
HD-4060R	Initial Factory Fill: 40 Qts. (38 L)	Service Fill: 25 Qts. (23 L)
	Note: Capacities are approximate only. Please check dipstick levels with the proper “Fluid Level Check” procedure.	*Note: Capacities shown are for 4-1/2” deep oil pan.*

SECTION 13B4

ELECTRONIC CONTROL SYSTEM

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 13B4-1
Components 13B4 1
Maintenance 13B4-3
Troubleshooting 13B4-3

GENERAL DESCRIPTION

The Allison automatic transmissions installed on 102D series coaches utilize Allison Transmission Electronic Control (ATEC) or World Transmission (WT) electronic control systems. The electronic control systems governs the upshift, downshift, lock-up and fault lock-in functions of transmission operation, including operations in less than nominal operating conditions.

NOTE: The control system monitors itself for fault conditions and/or operation that could result in damage or unsafe coach operations. When these conditions are detected the unit is programmed to respond automatically in a manner which is safest for the occupants, vehicle and transmission.

These control systems generally consist of several major components connected through chassis wire harness. Among these are the Electronic Control Unit (ECU), the engine Throttle Position Sensor (TPS) or Serial Communication Interface (SCI) or a more direct electronic communication as provided by an electronic accelerator pedal assembly, various speed sensors, shift selector, and an internal control module, which contains the solenoid valves and pressure switches.

The throttle position sensor, speed sensors, pressure switch, and shift selector transmit information to the ECU. The ECU in turn processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

NOTE: Throttle Position Sensors (TPS) are used with non-electronic engine installations only. Some electronically controlled Caterpillar and Cummins engine installations may have required a Vehicle Interface Module (VIM) to conform to SAE J1708 and J1587.

COMPONENTS

ELECTRONIC CONTROL UNIT

Coaches equipped with the HT-741, HT-746 and HT-755 ATEC model transmission installations feature the “Splashproof Standard” (sealed) or “Sealed Plus II” electronic control units (Figure 1).

Coaches equipped with the B500 and HD-4060 series transmissions feature the WT electronic control system utilizing the “Basic” or “Maxi-Feature” electronic control unit. The ECU for both systems is mounted in the overhead ATEC/DDEC control box located in the LH #1 baggage bay.

NOTE: The ATEC/DDEC control box is located in the LH #3 baggage bay on earlier model coaches. The “Maxi-Feature” ECU is used on retarder installations only.

The control system ECU is an electronic microcomputer which receives information in the form of electronic signals from the various sensors, processes the information, and sends electronic signals to the appropriate solenoids which control the transmission operation.

The WT control system ECU has the unique ability to adapt or “learn” as it operates. Each shift is electronically measured, stored, and used by the ECU to adapt to the optimum conditions for future clutch application and release.

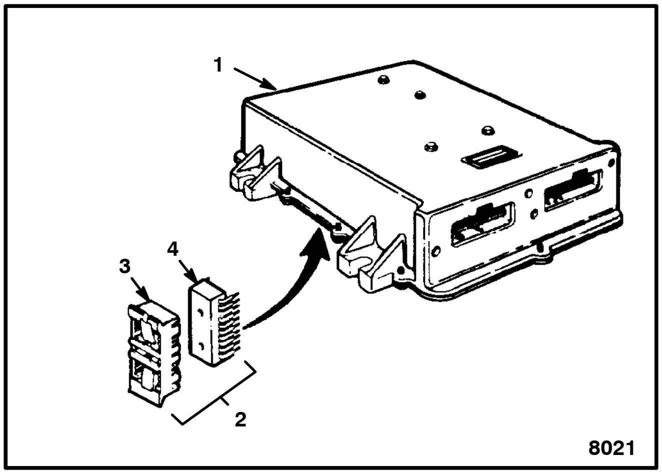


Figure 1. ECU & EPROM Assembly

The ECU on (ATEC) control systems contain an Electronically Programmable Read-Only Memory (EPROM) microchip. The ECU on (WT) control systems contain an Electronically Erasable Programmable Read-Only Memory (EEPROM) microchip. These EPROMS EEPROMS contains the same shift calibration for the specific transmission installations along with other constants that dictate transmission and/or retarder operations.

⚠ CAUTION ⚠

The EPROMS and EEPROMS are designed for specific combinations of drive axle ratios, transmission models and tire sizes. Any appreciable difference in the replacement of such items, may result in the need to replace the EPROM with one which is more compatible, or reconfigure the EEPROM with the newer combination of equipment. Failure to do so may result in reduced transmission performance.

NOTE: The WT electronic control units do not have serviceable PROM assemblies. Proms parameters may be reprogrammed only at specific Allison service center locations.

This PROM/ECU assembly number is used to determine the specific encoded information of the electronic control unit for servicing or corrective action. Refer to the Allison parts manual for the correct service replacement ECU part number, or the service part number for a remanufactured ECU without PROM.

An EPROM assembly (key #2) consists of two serviceable parts which are the EPROM retainer (key #3) and the EPROM (key #4). Both parts along with an ECU makeup a complete PROM/ECU assembly (key #1) (Figure 1). This assembly part number is displayed on the identification label attached to the ECU. An electronic Diagnostic Data Reader (DDR) for ATEC transmissions can also be used to identify the correct PROM/ECU assembly part number.

NOTE: An ATEC electronic control unit can only be obtained in the incomplete form (without EPROM).

HARNESSES

The ATEC electronic control unit harnesses utilize two 30-terminal input/output connectors (Figure 2). The splash-proof connectors are held in place by a center screw attachment. An electrical connector removal tool is available from Kent-Moore P/N J35813.

The WT electronic control unit is interconnected to the Vehicle Interface Module (VIM) by harness. This harness utilizes one Packard 18-pin ECU output connector, and one Packard 30-pin coach components output connector. This splash-proof connector is held in place by a center screw attachment. The ECU input/output harness connectors are twin Thomas & Betts 34-pin connectors. These connectors are held in place by snap clip attachments.

NOTE: WT electronic control system block change revision from version 6 to version 7, which occurred with unit #46704, entailed harness connectors and enhanced ECU parameters.

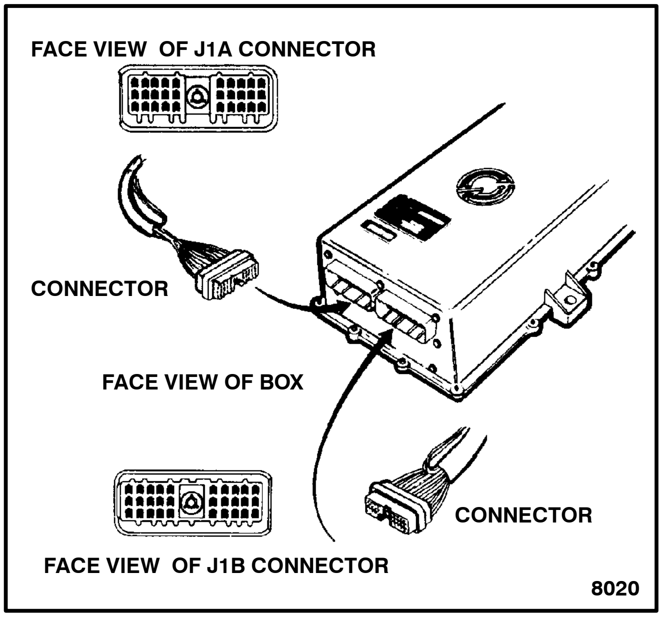


Figure 2. Electronic Control Unit

MAINTENANCE

ELECTRONIC CONTROL UNIT

NOTE: It is important to note for WT equipped coaches, that if the shift quality of a low-mileage transmission with new or recalibrated ECU is unacceptable, simply drive the coach through its normal shift ranges a few times. After a short learning period, any rough shifting should be corrected and shift quality restored.

PROM Service (ATEC)

The replacement EPROM is available only in the service PROM kit. Specific shift points for the various PROM kits are listed in Allison's *"ECU/PROM Calibration and Shift Points Data*" manual (SA 2058).

A PROM and retainer (5) service kit is also available, and consists of: PROM and retainer assembly, security label (for access cover), part number identification label and instruction sheet.

An Allison *"ECU/PROM Calibration and Shift Points Data*" manual (SA 2058) for ATEC transmissions is available through authorized Allison distributors. This manual provides service ECU and service PROM kit part numbers along with calibration and shift points data for the ATEC series transmissions. When ordering new ECU's, also order a new service PROM kit (PROM/Retainer Assembly) to be compatible with the new ECU. Select the kit that has the same calibration as the old PROM.

Reset Procedures

Most of the minor or temporary transmission faults that would initiate a "Do Not Shift" tell-tale light may be cleared by using the following procedures.

On ATEC control systems to attempt reset and with the selector in (N), position the selector to (R) then back to (N) and then to (D) range once.

On WT control systems to attempt reset and with the selector in (N), simultaneously press the "Up" and "Down" (symboled) arrow buttons twice. Press and hold the "Mode" button until a tone is heard, release button and return to normal operation.

Another common reset procedure requires that the transmission be placed in (N), shut off engine and wait about 10 seconds before restarting.

NOTE: If the condition is minor or temporary, the tell-tale will not come back on and the transmission should operate normally. If the condition is more serious, the tell-tale will again light and the transmission may remain inhibited or operate in a normal manner until the condition is detected again. However, direction changes will not occur, and the type of operation permitted by the ECM will depend on the type of problem or fault existing. In a severe fault situation the transmission could possibly remain in the neutral position during an attempted reset procedure.

ECU REMOVAL

1. Place battery disconnect switch "Off". Apply the parking brake.

2. Disconnect all electrical harnesses to and from the ECU.

3. Unfasten and remove the ECU mounting capscrews and remove the ECU from the ATEC/DDEC control box.

ECU INSTALLATION

1. Reinstall in reverse order of the "Removal" procedure.

TROUBLESHOOTING

DIAGNOSTIC CODES

If the value of any of the transmitted signals is not within the limits programmed into the ECU memory, the ECU will turn on the "CHECK TRANS" light on the tell-tale warning cluster and a diagnostic code will be logged into the memory. All codes fall into one of two categories, soft or hard. A soft code does not interfere with the operation of the vehicle. A hard code will cause the ECU to limit the operation of the transmission to protect it from damage and will also turn on the "DO NOT SHIFT" light. The diagnostic code identifies the problem circuit. A circuit consists of a component which sends or receives a signal (such as a speed sensor), the harness wiring, connectors and/or the ECU.

Two methods are used to read the diagnostic code. The most common of these is to place the transmission diagnostic test switch to "ON" which should cause the code to flash. The second method involves connecting a display dataline (DDL) reader into the harness plug provided in either the DDEC/ATEC control box, or under the driver's seat. The DDL will read the diagnostic codes from the ECU memory. One hard code and one soft code can be retained in the ECU's memory and be displayed at any time.

NOTE: The memory of the ECU will only store two diagnostic codes; however, more than two problems may exist. The first two codes should be corrected and cleared and any remaining problems, if present, will then be logged into the ECU.

When the test switch is on, the ECU will flash the diagnostic code. For example, a code 12 would consist of one flash followed by a short pause, then two flashes in quick succession. After a long pause, the code should repeat. This process continues as long as the test switch is "ON". Only one code will be flashed out. The second code will be stored until the first code is fixed and cleared from the ECU memory. To clear a code, the test switch must first be in the "ON" position and the transmission in neutral. Next, select reverse and then re-select neutral. If a code does not clear, the problem is still present and must first be corrected before it can be cleared. Diagnostic codes should be cleared after repairs have been completed.

NOTE: After clearing, some codes may require several cycles of "Keystarting".

ELECTRICAL CHECKS

Normally, a trouble code indicates the computer has detected an improper resistance or condition in the component named by the code, or in the wiring to that component. The technician should first follow the normal procedure published in the troubleshooting manual, which checks the component and wiring for opens, short circuits between wires and short circuits to ground. The technician may use the single page schematic of the ATEC system in Appendix I of the troubleshooting manual to perform most of these checks. This will fix many of the trouble codes coaches may experience.

If after the normal troubleshooting procedures are followed and no cause for the code is found, some other potential causes for codes are as follows:

1. The ATEC system requires battery direct ground. These are ATEC Wires 208 and 209. If these wires are not battery direct, are common to other electrical equipment grounds, the connection to ground is loose, or the connection to ground is painted or dirty, intermittent codes may result.

2. The ATEC system also requires battery direct power. These are wires 202 and 223. If input power has fluctuations, or is intermittent, codes may result. Check for other 12 vdc loads off of the ECU power (i.e., radios, lights, horns, etc.).

3. Wire 201 must be grounded to the chassis. This wire is the short wire which comes out of the chassis harness connector at the ECU, and normally has a tag on it instructing the reader to ground this wire. Wire 201 is a part of the ATEC system's protection against outside interference.

4. An area where a ground can be difficult to detect is in the end bell area of the chassis harness. If a wire has rubbed through its insulation and contacted the end bell, a short to ground exists. When the chassis harness is removed from the bulkhead connector, the short to ground is broken. To detect a short between a wire and the end bell, the volt-ohmmeter should check between the end bell and all pins in the chassis harness connector (Figure 3). The wires in this area should also be carefully inspected for damage.

5. Another area which may generate a short to ground that is intermittent and difficult to detect is a short between internal harness wires and the valve body or oil filter. The internal harness should be carefully inspected with a light to expose worn areas in the internal harness that will intermittently contact surrounding metal.

6. Corroded or dirty connections at the chassis harness connector will cause intermittent diodes.This area must only be cleaned with a contact cleaner consisting of at least 90% freon. Cleaners containing petroleum distillates will damage the connector.

7. When experiencing intermittent solenoid codes, particularly those involving the latching solenoids, bad solenoid lead wire to terminal crimps have been found in several locations. The latching solenoids are connected together in a chain, therefore, resistance problems in one solenoid circuit in the chain may affect the generation of trouble codes for other solenoids, due to the way the ECU measures the resistance of the latching solenoid chair. These crimps may be soldered or recrimped to prevent this condition from occurring. An illustration of these parts follows (Figure 6).

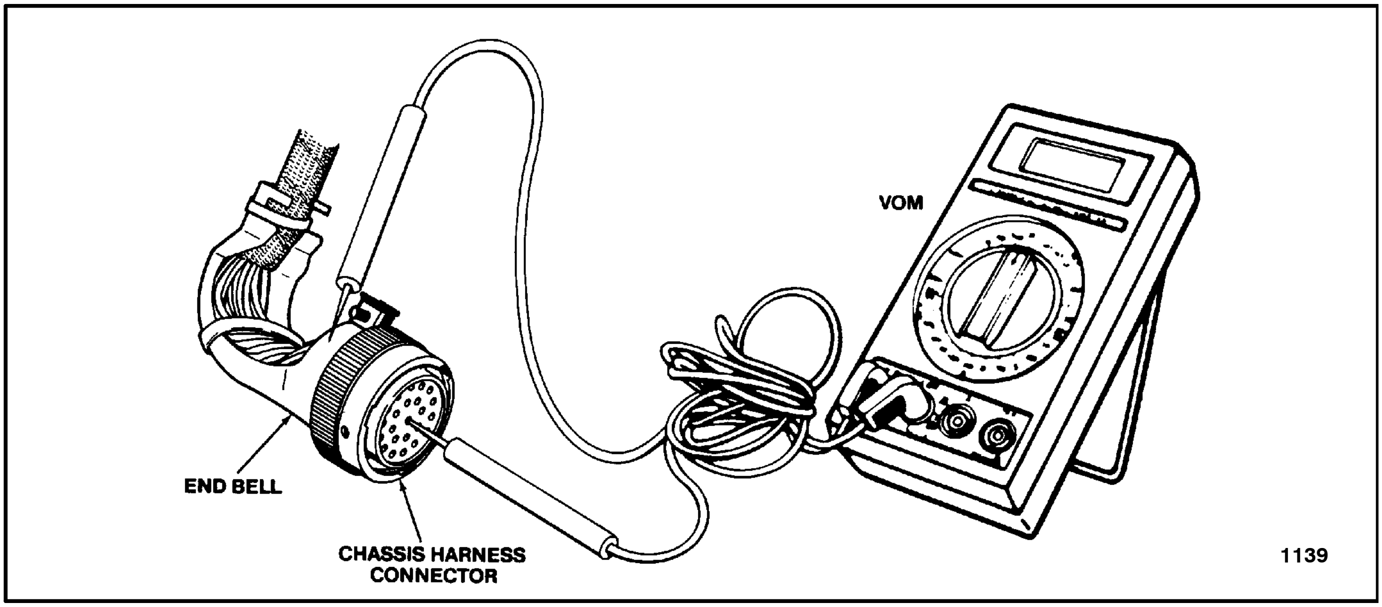


Figure 3. Harness Check

DIAGNOSTIC DATA READER

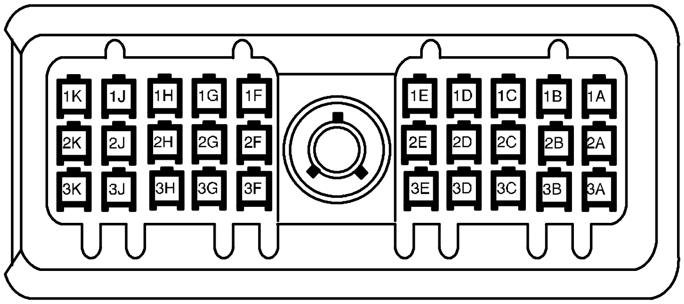
The Diagnostic Data Reader (DDR) is an optional service device available through Allison service tool sources Kent-Moore P/N J38538. The purpose of the DDR device (also known as the “ProLink 9000”) is to assist in the installation check-out and troubleshooting of transmission malfunctions as detected by the ECU. The DDR may also be used to modify certain shift calibration parameters.

The DDR is a portable microcomputer-based receiver/transmitter/display unit. The DDR transmits and receives data to and from the ECU, processes the data and displays appropriate information to the servicer. Operating instructions are supplied with each DDR

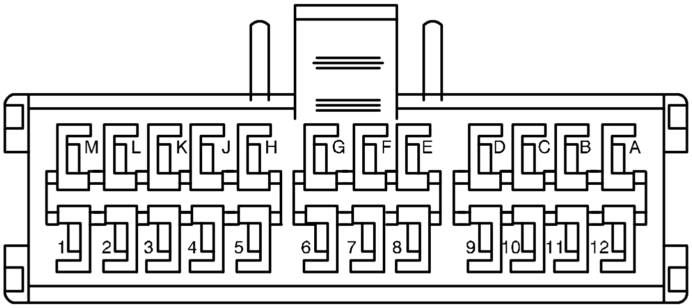
CONNECTOR PIN CHARTS

To provide troubleshooting coverage for ATEC systems with Splashproof Standard Electronic Control Unit connectors, and earlier Sealed Plus I & II ECU’s the following connector pin charts are provided. These charts will enable service technicians to perform troubleshooting on most ATEC systems using the existing splash-proof troubleshooting manuals (Figures 4 and 5).

NOTE: Connector pin information for WT electronic control harnesses are not shown.



SEALED HARNESS TO ECU J–J1A CONNECTOR (WHITE)



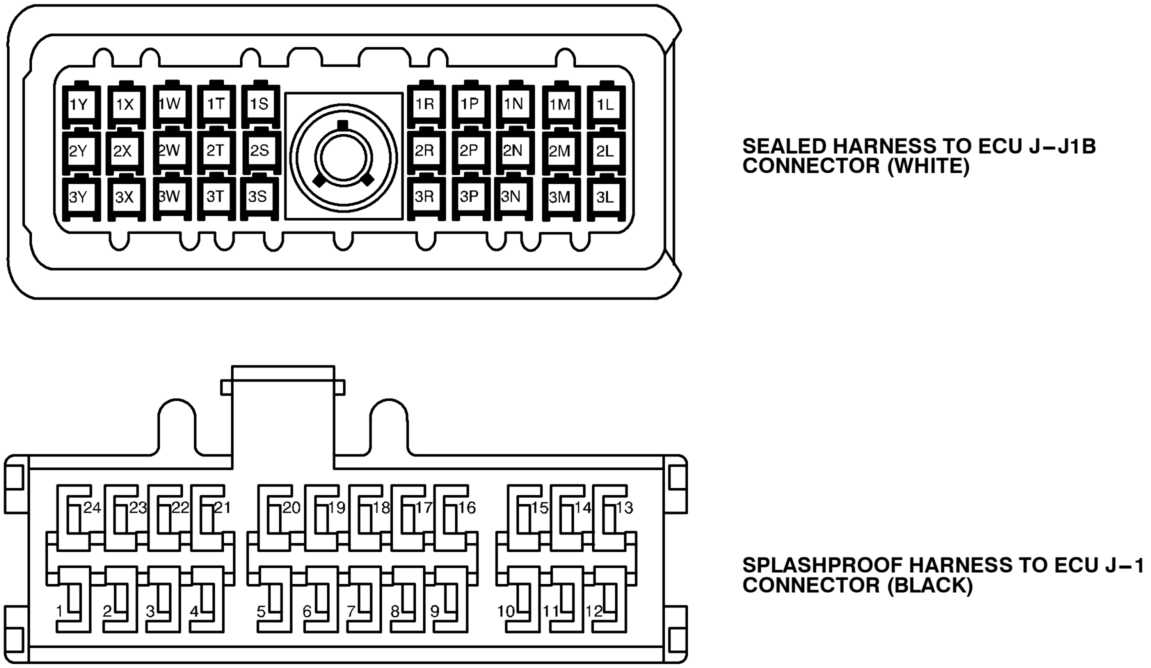
SPLASHPROOF HARNESS TO ECU J–2 CONNECTOR (BLACK)

* WIRE COLORS MAY NOT BE CONSISTANT WITH HARNESS

SEALED CONNECTOR J–1A	SPLASHPROOF CONNECTOR J–2	CIRCUIT NO.	WIRE COLOR*	CIRCUIT
2K	1	201	WHITE	VEHICLE CHASSIS – GROUND
2A	2	202A	RED	+ 12V POWER
3A	3	203	BLUE	CONTINOUS POWERED MEMORY (12V)
1F	4	204	WHITE	SHIFT SELECTOR
3G	5	205	GREEN	SPEEDOMETER
1G	6	206	VIOLET	SHIFT SELECTOR
1J	7	207A	BLUE	DDL/DIGITAL DISPLAY
1A	8	208	BLACK	BATTERY – GROUND
1B	9	209	BLACK	BATTERY – GROUND
2C	10	210A	BLACK	GROUND
3F	11	211	YELLOW	RETARDER – IN
3J	12	212	RED	DO NOT SHIFT
3D	A	213	BLUE	RETARDER – OUT
2D	B	214	WHITE	REVERSE
3H	C	215	VIOLET	CHECK TRANS – OUT
2J	D	216A	YELLOW	TEST SWITCH
1E	E	217	VIOLET	2 SPEED GOVERRNOR
1H	F	218	BLUE	SHIFT SELECTOR
2H	G	219	GREEN	SHIFT SELECTOR
2G	H	220	YELLOW	SHIFT SELECTOR
2F	J	221	VIOLET	SHIFT SELECTOR
1K	–	222	RED	SPL PURPOSE INPUT
2B	L	223A	RED	+ 12V POWER
3K	–	224	WHITE	SPL PURPOSE OUTPUT

8027

Figure 4. ECU J-1 (OR J-1B) Connector

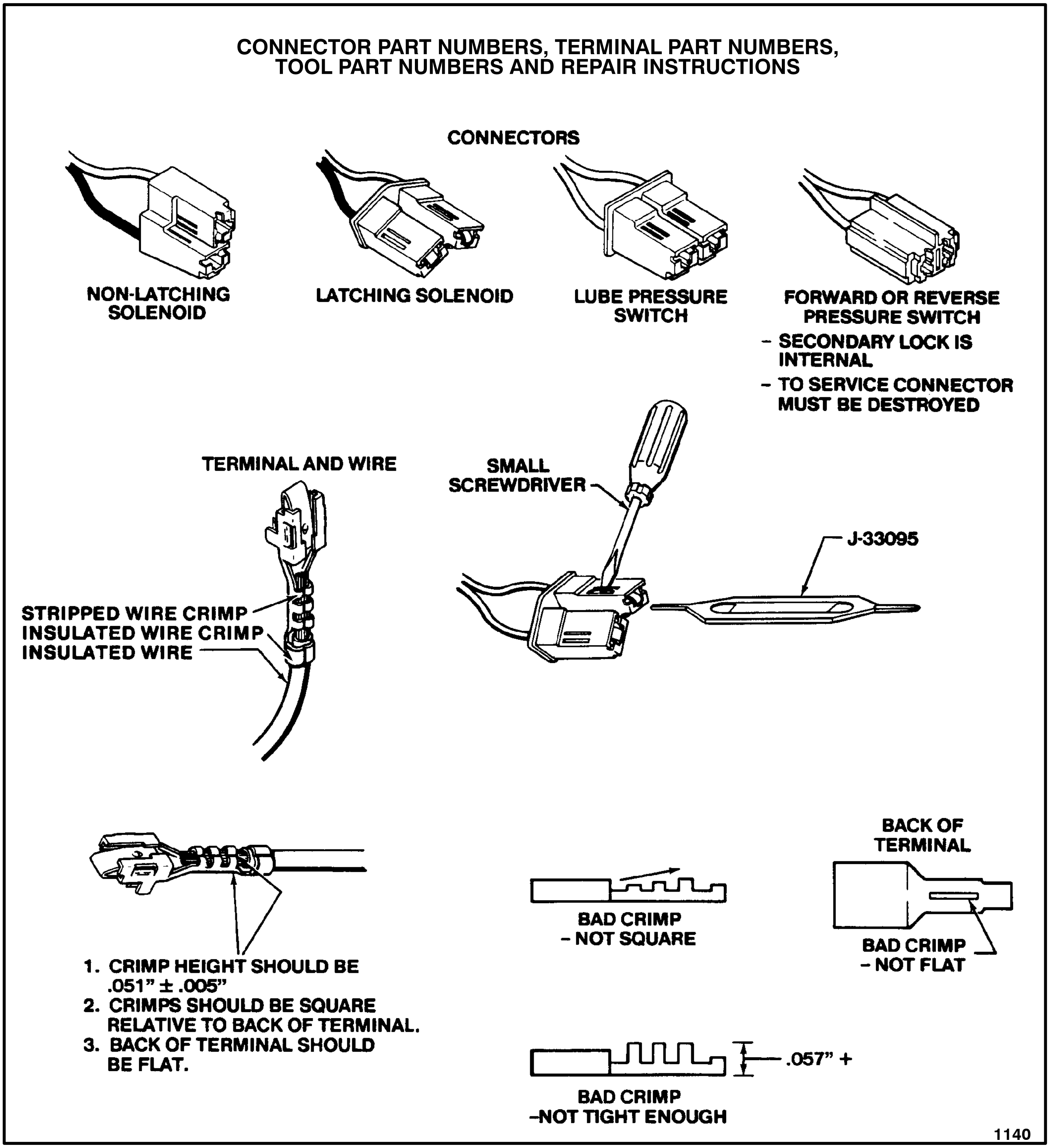

1Y 1X 1W 1T 1S 1R 1P 1N 1M 1L
2Y 2X 2W 2T 2S 2R 2P 2N 2M 2L
3Y 3X 3W 3T 3S 3R 3P 3N 3M 3L
SEALED HARNESS TO ECU J–J1B CONNECTOR (WHITE)
24 23 22 21 20 19 18 17 16 15 14 13
1 2 3 4 5 6 7 8 9 10 11 12
SPLASHPROOF HARNESS TO ECU J–1 CONNECTOR (BLACK)

* WIRE COLORS MAY NOT BE CONSISTANT WITH HARNESS

SEALED CONNECTOR J–1B	SPLASHPROOF CONNECTOR J–1	CIRCUIT NO.	WIRE COLOR*	CIRCUIT
2N	1	101	RED	12V
–	2	–	–	SPARE
–	3	–	–	SPARE
2P	4	104	YELLOW	THROTTLE SENSOR – PIN B
1W	5	105	VIOLET	B AND F SOLENOID
1N	6	106A	BLACK	THROTTLE SENSOR – PIN C
1Y	7	107	GREEN	LOCKUP SOLENOID G–
2M	8	108	YELLOW	NEUTRAL SOLENOID H+
2Y	9	109	BLUE	LOCKUP SOLENOID G+
1S	10	110	WHITE	C AND D SOLENOID
3M	11	111	GREEN	J SOLENOID
1L	12	112	WHITE	SPEED SENSOR HIGH – PIN B
1M	13	113	BLACK	SPEED SENSOR LOW – PIN A
3L	14	114	WHITE	J AND C SOLENOID
1T	15	115	GREEN	A AND B (5 SPEED ONLY)
1R	16	116	YELLOW	REVERSE PRESSURE SWITCH
3Y	17	117	BLACK	H AND E SOLENOID
3P	18	118	BLUE	FORWARD PRESSURE SWITCH
2W	19	119	RED	TRIM BOOST SOLENOID E+
2T	20	120	BLUE	D AND F SOLENOID
3T	21	121	RED	SOLENOID – B (4 SPD) – A (5 SPD)
3N	22	122	VIOLET	LUBE PRESSURE SWITCH
2L	23	123	VIOLET	TEMPERATURE SENSOR +
1P	24	124	RED	THROTTLE SENSOR – PIN A

8028

Figure 5. ECU J-2 (or J-1A) Connector


CONNECTOR PART NUMBERS, TERMINAL PART NUMBERS,
TOOL PART NUMBERS AND REPAIR INSTRUCTIONS
CONNECTORS
NON-LATCHING SOLENOID
LATCHING SOLENOID
LUBE PRESSURE SWITCH
FORWARD OR REVERSE PRESSURE SWITCH
- SECONDARY LOCK IS INTERNAL
- TO SERVICE CONNECTOR MUST BE DESTROYED
TERMINAL AND WIRE
STRIPPED WIRE CRIMP
INSULATED WIRE CRIMP
INSULATED WIRE
SMALL SCREWDRIVER
J-33095
BACK OF TERMINAL
BAD CRIMP - NOT SQUARE
BAD CRIMP - NOT FLAT
.057" +
BAD CRIMP -NOT TIGHT ENOUGH
1140

1. CRIMP HEIGHT SHOULD BE .051" ± .005"
2. CRIMPS SHOULD BE SQUARE RELATIVE TO BACK OF TERMINAL.
3. BACK OF TERMINAL SHOULD BE FLAT.

Figure 6. Connectors

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

MCI 102D SERIES MAINTENANCE MANUAL

Date January 1998

SECTION 14

DRIVESHAFT

SECTION 14

DRIVESHAFT

CONTENTS OF THIS SECTION

SUBJECT PAGE
General Description 14-1
Components 14-1
Maintenance 14-1
Specifications 14-4

GENERAL DESCRIPTION

The driveshaft transmits power from the transmission to the differential. The driveshaft is of the tubular type and uses two heavy duty needle bearing universal joints. A slip-joint type construction compensates for variations in distance between the transmission and differential brought about by the rise and fall of the rear axle as the coach passes over uneven surfaces. The slip joint type construction also facilitates removal, as it can be collapsed (Figure 1).

COMPONENTS

SLIP-JOINT ASSEMBLY

The slip-joint assembly is fabricated from a heavy wall forging and machined to accept the splined end of the tight-joint. One end has a half-round yoke welded to it and the other has a threaded dust cap and seal attached. A grease fitting is installed into the slip-joint assembly.

TIGHT-JOINT ASSEMBLY

The tight-joint assembly is fabricated from a heavy wall tubing. One end has a half-round yoke welded to it and the other has a slip tube splined shaft welded to the tube.

UNIVERSAL JOINT (BEARING)

The U-joint has two retaining cap journal bearings for attaching the U-joint to the driveshaft yokes and two plain journal bearing caps for attaching the U-joints to the transmission or differential. The D Series coaches use only 1810 Series universal joints.

CAUTION

When assembling the driveshaft, the arrow on the tight end and slip joint end must align at the joining areas. This will align the tight end and slip joint end yoke trunnions.

MAINTENANCE

LUBRICATION

Universal Joints

Both universal joint bearings are provided with grease fittings. To ensure proper lubrication of all bearing assemblies, it is essential to add grease until it appears at all journal cross bearing seals. This assures removal of dirt particles and other contaminants that may find their way into the bearings and indicates that the bearings are fully lubricated.

NOTE: Journal cross seals are designed to relieve, however, if all the seals do not “pop” when being lubed, move the driveshaft laterally in all four directions and pull or push on the driveshaft in the direction opposite to the journal cross seal not relieving while lube gun pressure is being applied to the alemite fitting. An increase in line pressure may also be necessary.

Do not assume that bearing cavities have been filled with new lubricant unless flow is noticed around all four bearing seals. If seals fail to purge, cup removal may be necessary to remove the obstruction and promote lubrication.

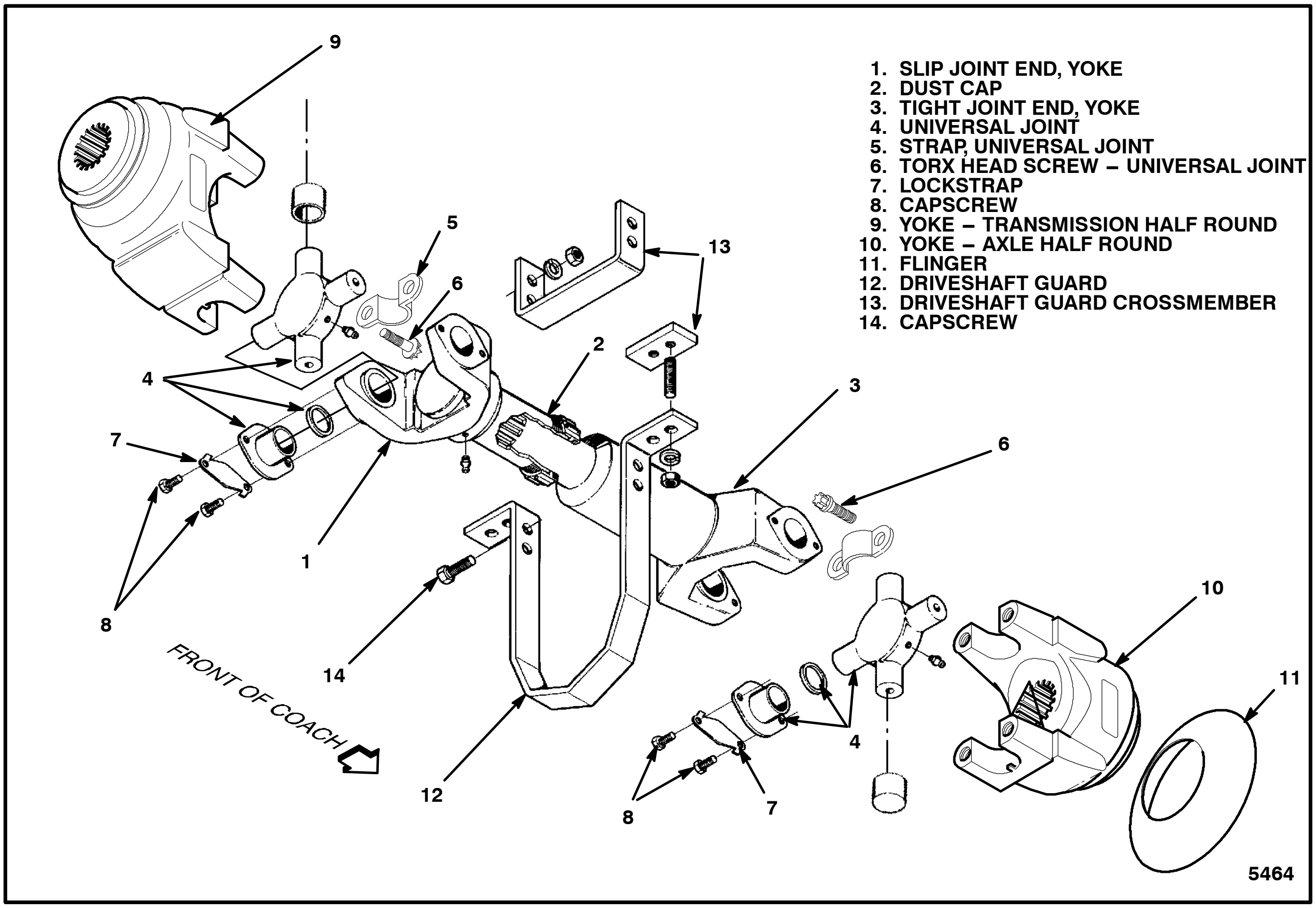

1. SLIP JOINT END, YOKE
2. DUST CAP
3. TIGHT JOINT END, YOKE
4. UNIVERSAL JOINT
5. STRAP, UNIVERSAL JOINT
6. TORX HEAD SCREW – UNIVERSAL JOINT
7. LOCKSTRAP
8. CAPSCREW
9. YOKE – TRANSMISSION HALF ROUND
10. YOKE – AXLE HALF ROUND
11. FLINGER
12. DRIVESHAFT GUARD
13. DRIVESHAFT GUARD CROSSMEMBER
14. CAPSCREW
9
5
13
6
2
4
3
7
6
1
8
10
14
11
FRONT OF COACH
4
12
8
7
5464

Figure 1. Half-round End Yoke Driveshaft

Driveshaft Assembly

A third lubrication fitting is provided in the slip joint assembly for lubrication of the splined shaft. Factory assembled driveshafts are lubricated at the plant prior to shipment. When installing replacement assemblies, it is recommended that this fitting be lubricated after installation of the driveshaft prior to putting vehicle in service.

The driveshaft U-Joint and Slip-Joint lubrication fittings should be serviced every 10,000 miles (16,000 km) or 300 hours using lubrication specification S-17 (Mutli-Purpose Grease EP2). Wipe all excess grease from the driveshaft.

NOTE: High quality extreme pressure (EP) grease is recommended for universal joints. Lithium soap base greases meeting NLGI Grade 1 or 2 specifications are preferred. The use of greases that tend to separate and cake should be avoided. Relubrication cycles for driveshaft universal joints and slip splines vary with operating conditions.

PERIODIC INSPECTIONS

Driveshaft universal joint fasteners should be checked at regular inspection intervals for loose or broken bolts. When servicing the driveshaft, use only new bolts.

The recommended torque value for the retaining cap journal bearing capscrews on the full round yokes is 38-48 ft-lbs (51-65 N·m) above the prevailing torque for the plastic insert style 12 point capscrews. The recommended torque value for the retaining strap half round journal bearing12 point capscrews are 130-135 ft-lbs (176-183 N·m) (Figure 2).

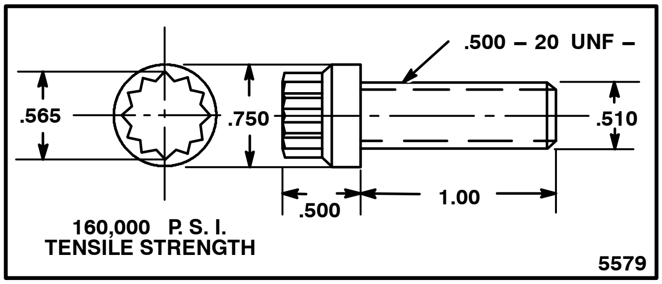

.500 – 20 UNF –
.565
.750
.510
.500
1.00
160,000 P. S. I.
TENSILE STRENGTH
5579

Figure 2. Driveshaft Half Round Yoke Bolts

Any unusual noises are vibrations should be checked immediately. Noise and vibration in the driveline often originate in the driveshaft. Noise and vibration originating in the universal joint and driveshaft assembly appear only at certain speeds. Common causes of driveshaft and universal joint vibration are:

a. Driveshaft assembly out of balance.
b. Distorted or cracked yokes.
c. Loose yoke strap capscrews.
d. Universal joint yoke misalignment.
e. Bearing failure.

REMOVAL

The driveshaft may be removed from the vehicle by following this procedure.

1. Turn battery disconnect switch to “OFF” position.
2. Unfasten and remove the driveshaft guard collar.
3. Unfasten and remove the 12-point capscrews which attach the half-round bearing journal strap to the differential’s half-round yoke (Figure 3).
4. Remove the half-round bearing journals from yoke by moving slip-joint in on tight-joint splined shaft.
5. Unfasten and remove the capscrews which attach the half-round bearing journal strap to the transmission’s half-round yoke, and remove from vehicle.

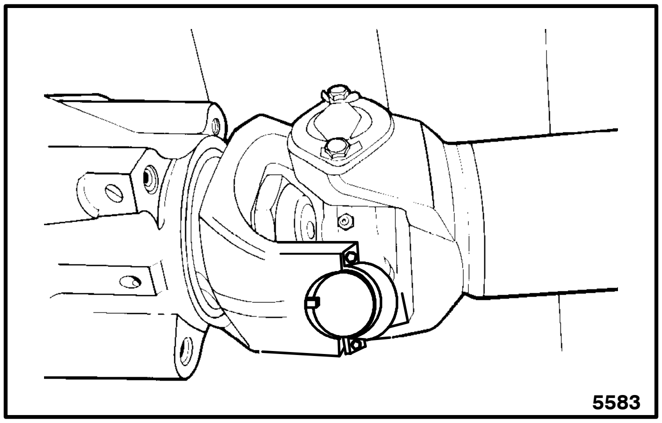


Figure 3. U-Joint Mounting Bolts

DISASSEMBLY

1. Turn battery disconnect switch to “OFF” position.
2. Unfasten and remove the 12-point capscrews which attach the bearing journal cap to the full-round yokes.

NOTE: Older style universal joints with locking tabs will need to be bent down to gain access to the capscrews.

3. Lift the journal caps and remove the bearing cross from the yoke.

CLEANING AND INSPECTION

Thoroughly clean grease from bearings, journals, and other parts. Clean all lubricant passages in the cross and the lubrication fittings (Figure 4). Needle bearing assemblies may be soaked in cleaning solution to soften particles of hard grease. It is extremely important that bearing assemblies be absolutely clean, since even very small particles of dirt or grit can cause rapid bearing wear. Do not attempt to disassemble needle bearings.

Cross bearing journal areas should be inspected for roughness or grooving (brinelling). Excessive wear of the needle bearings is indicated if the needles drop out of the retainer, or if marks are present on the journal bearing surface. If brinelling is indicated, the entire U-joint assembly should be replaced. Inspect yokes for cracks, wear or distortion.

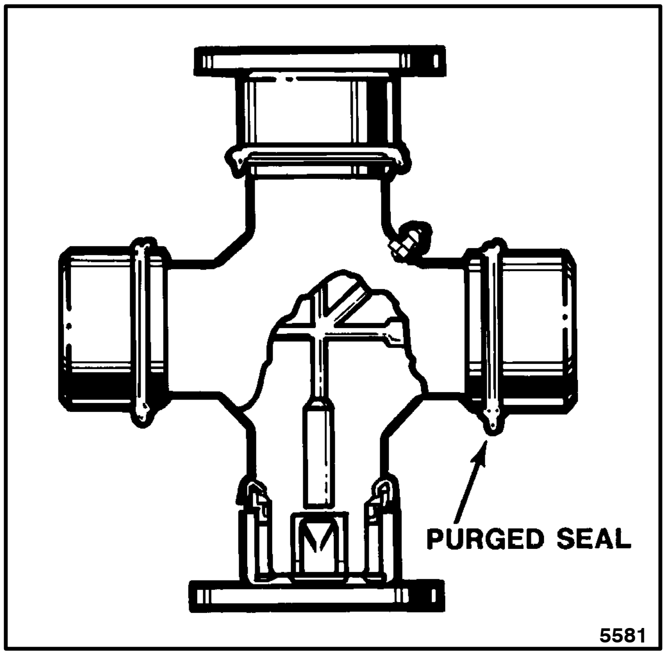


Figure 4. Lubrication Passages

ASSEMBLY

1. Reassemble in reverse order of the “Disassembly” procedure.
2. Tighten the 12 point capscrews to 38-48 ft-lbs (51-65 N·m) above the prevailing torque for the plastic insert.

INSTALLATION

1. Collapse driveshaft and reinstall in reverse order of the “Removal” procedure, with the slip-joint end toward the differential.
2. Tighten the 12 point capscrews to 130-135 ft-lbs (176-183 N·m) torque, and the driveshaft guard collar mounting bolts to 25 ft-lbs (34 N·m).

SPECIFICATIONS

DRIVESHAFT ASSEMBLY (102DL3)

Part Number (8V-92 W/Fuller 5-Speed Installation)	(52.8” Minimum Length) 14L-1-173
Part Number (8V-92 W/HT-740 or HT-741 Installation)	(44.4” Minimum Length) 14L-1-168
Part Number (8V-92 W/HTB-748 Installation)	(44.3” Minimum Length) 14L-1-168
Part Number (8V-92 W/HT-755 Installation)	(40.5” Minimum Length) 14L-1-172
Part Number (Series 60 W/Fuller 7-Speed Installation)	(35.4” Minimum Length) 14L-1-188
Part Number (Series 60 WFuller 10-Speed Semi-Auto Installation)	(35.4” Minimum Length) 14L-1-188
Part Number (Series 60 W/HT-740 or HT-741 Installation)	(30.3” Minimum Length) 14L-1-195
Part Number (Series 60 W/HT-755 Installation)	(26.4” Minimum Length) 14L-1-196
Part Number (Series 60 W/HT-746 Installation)	(34.7” Minimum Length) 14L-1-188
Part Number (Series 60 WB500/B500R Installation)	(35.4” Minimum Length) 14L-1-188
Part Number (Cat/Cummins W/Fuller 5-Speed Installation)	(43.3” Minimum Length) 14L-1-225
Part Number (Cat/Cummins W/Fuller 7-Speed Installation)	(39.6” Minimum Length) 14L-1-197
Part Number (Cat W/Fuller 10-Speed Installation Replaces 14L-1-209)	(36.1” Minimum Length) 14L-1-188
Part Number (Caterpillar W/Fuller 10-Speed Semi-Auto Installation)	(39.9” Minimum Length) 14L-1-197
Part Number (Caterpillar W/HT-740 or HT-741 Installation)	(34.7” Minimum Length) 14L-1-188
Part Number (Cummins W/HT-740 Installation)	(32.7” Minimum Length) 14L-1-136
Part Number (Cat/Cummins W/HT-755 Installation)	(30.7” Minimum Length) 14L-1-226
Part Number (Caterpillar W/HT-746 Installation)	(40” Minimum Length) 14L-1-197
Series	1810
Style	Half-Round
Spline Diameter	3”
Spline Length	4-1/2”

DRIVESHAFT ASSEMBLY (102D3)

Part Number (Series 60 W/Fuller 5-Speed Installation)	(18.9” Minimum Length) 14L-1-88
Part Number (Series 60 W/Fuller 7-Speed Installation)	(15.2” Minimum Length) 14L-1-213
Part Number (Series 60 WFuller 10-Speed Semi-Auto Installation)	(13.9” Minimum Length) 14L-1-160
Part Number (Series 60 W/HT-746 Installation)	(14.2” Minimum Length) 14L-1-160
Part Number (Series 60 WB500/B500R Installation)	(15.4” Minimum Length) 14L-1-213
Part Number (Cat/Cummins W/Fuller 5-Speed Installation)	(22.2” Minimum Length) 14L-1-220
Part Number (Cat/Cummins W/Fuller 7-Speed Installation)	(18.5” Minimum Length) 14L-1-88
Part Number (Caterpillar W/Fuller 10-Speed Semi-Auto Installation)	(18.4” Minimum Length) 14L-1-88
Part Number (Cat/Cummins W/HT-740 or HT-741 Installation)	(13.5” Minimum Length) 14L-1-221
Part Number (Cat/Cummins W/HT-746 Installation)	(18.1” Minimum Length) 14L-1-88
Series	1810
Style	Half-Round
Spline Diameter	3”
Spline Length	4-1/2”

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 15

WHEELS, HUBS AND TIRES

This section consists of three primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The three primary subsections are:

A - Wheels
B - Hubs
C - Tires

SECTION 15A

WHEELS

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 15A-1

Maintenance 15A-2

Miscellaneous Torque Specifications 15A-6

GENERAL DESCRIPTION

Wheels and attaching hardware installed on the 102D series coach axles vary substantially from one type installation to another. Wheel installations differ according to the wheel manufacturer, tire type and size, wheel construction (steel vs aluminum) or style specified (stud-piloted vs hub-piloted).

NOTE: Basic equipment consists of stud-piloted steel wheel installations. Hub-piloted and aluminum wheel installations are optional.

Stud-piloted wheels use chamfered wheel stud holes to center the wheel against the hub. The hub-piloted wheels, which do not have chamfered stud holes, use the center hole to pilot the wheel onto the hub. Aluminum wheels are generally fabricated from thicker material than the steel wheels. Because of these basic wheel differences, each wheel installation will use specialized wheel mounting hardware to fasten the wheel to the axle hub and drum assembly (Figure 1).

Stud-piloted wheel installations use left hand threaded studs and nuts on the left side and right hand threaded studs and nuts on the right side of coach. Hub-piloted wheel installations use right hand threaded studs and nuts on both sides of coach. Hub-piloted wheel studs are slightly longer than the stud-mounted lengths, and aluminum wheel stud lengths are longer than steel wheel stud lengths.

Conventional cone shaped forged wheel nuts are generally used to attach the stud-piloted wheel installations. One-piece flanged type forged wheel nuts are also used on some stud-piloted installations, while a two-piece flanged type forged wheel nut is used on hub-piloted wheel installations. Additionally, a one piece fluted inner wheel nut is used on rear axle stud-piloted wheel installations to retain the inner wheel to the axle hub and drum assembly.

NOTE: Stud-piloted front steel wheel installations will be alternately fitted with the conventional cone-shaped wheel nuts and a one-piece flanged wheel nut. The conventional automotive type cone-shaped wheel nuts are used to align the wheel and the flanged type wheel nuts are used to hold the wheel in the proper location against the hub. Rear and trailing axle stud-piloted wheel installations use only the cone-shaped wheel nuts. All hub-piloted wheel installations are attached with the two-piece flanged type wheel nuts only.

Basic steel wheels are 22.50 x 8.25 inches (571.5 x 209.5 mm) with a 6.625 inch (168.1 mm) offset. These wheels are normally painted white and have a two or five hand hole design. Optional aluminum wheels are the same height, but vary in width between 8.25 and 9.00 inches (209.5 to228 mm) depending on tire size, and have offsets from 6.59 to 6.94 inches. Aluminum wheels have a polished finish and ten hand hole design.

NOTE: Wheels conform to The Tire and Rim Association specification SAE J694.

CAUTION

Stud-piloted cone-shaped wheel nuts should not be used to mount hub-piloted wheels. Do not use stud-piloted wheels in place of hub-piloted wheels. Do not adapt either type of wheel for a different mounting.

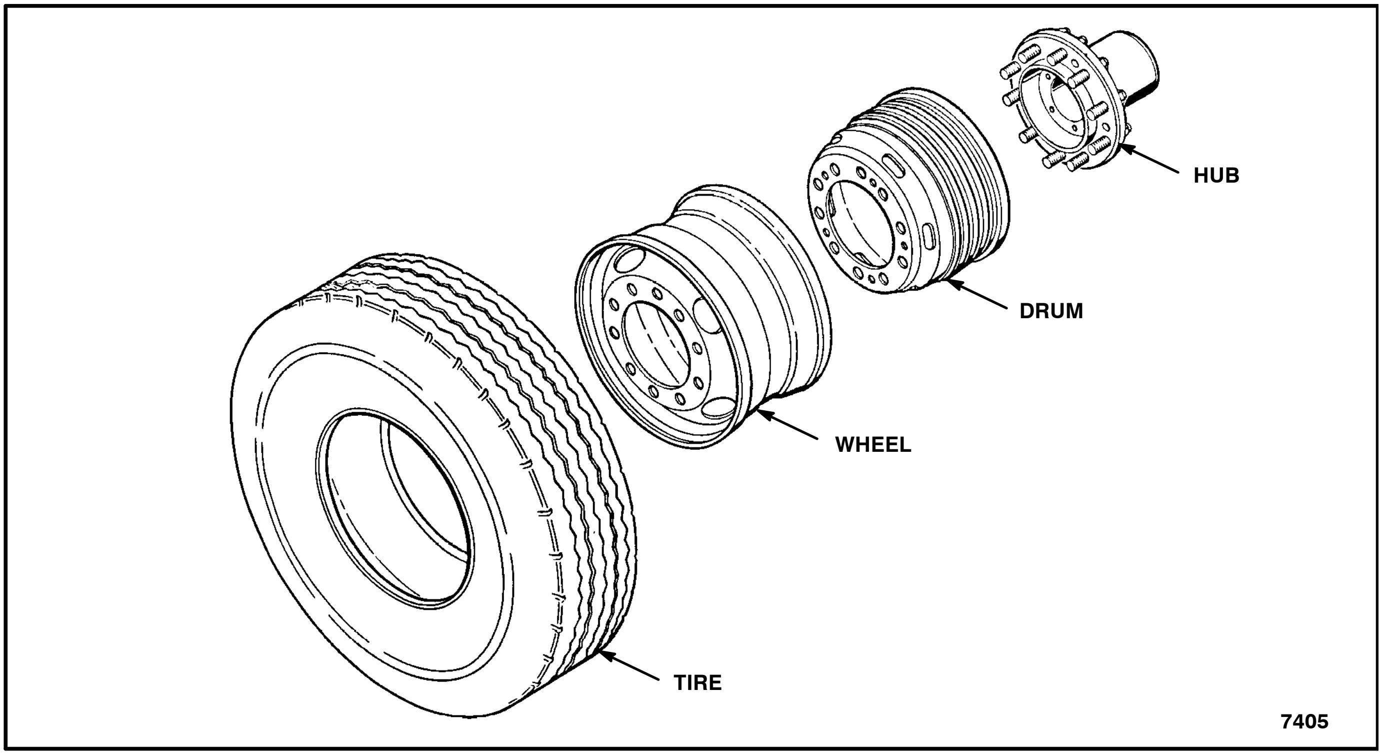


Figure 1. Tire, Wheel & Hub and Drum

MAINTENANCE

IMPORTANT: Steady or intermittent vibrations emanating from front or rear areas of coach could indicate one or more of the following conditions:

A. Drums, wheels and tires out of balance.

B. Improper attachment of wheels or hubs.

C. Mismatched or worn tires.

D. Improperly inflated tires.

E. Coach axles out of alignment.

F. Overloaded axle or suspension system.

⚠ WARNING ⚠

Never work under a unit supported only by a jack. Always support the coach with stands. Block the wheels before releasing park brake.

PERIODIC INSPECTION

The mounting and attachment of the wheel to the axle wheel end assembly is an important maintenance concern. The following periodic checks should be undertaken to maintain the best wheel and tire performance.

1. Check that wheel stud nuts are tightened to the proper torque specifications as shown at the end of this section.

2. Check that wheel stud rear locknuts are tightened to the proper torque specifications as shown at the end of this section

NOTE: Wheel stud nuts should be re-tightened every 100 miles (161 km) for the first 500 miles (805 km), and whenever new wheels have been installed.

3. Inspect all wheels for cracks, bent bead rims or other damage.

NOTE: A worn hub face could be caused by running wheels too loose. If the wear is not too excessive, the entire hub face can be machined flat. A badly worn hub should be replaced. Any broken or cracked hubs should be replaced.

⚠ CAUTION ⚠

Painting wheels can affect the torque retention of the wheel mounting nuts. Paint thickness and the hardness of the cured paint are the two factors that can affect the torque retention of the nuts. The current specification at MCI allows a 3.0-mil maximum thickness.

The wheel mounting nuts lose torque very quickly on freshly painted wheels. It is important to allow sufficient time for the paint to cure to a hard and durable state before putting the wheels into service. Baking the

newly painted wheels will accelerate the curing. Air drying requires approximately seven (7) days for proper curing.

An excessively thick coat of paint can cause a rapid loss of torque on the wheel nuts as the paint wears away. Remove any excessive paint from critical mounting surfaces.

NOTE: Wheel studs and nuts must be kept free from grease and oil. Normally no lubricant would be used when installing wheel attachment hardware, however, corrosion or galling of the stud and nut attachment may reach a point where removal can become difficult.

If extreme corrosion conditions are a persistent problem, a light application of anti-seize compound may be applied to the first three threads of the studs or fluted inner wheel nuts.

CAUTION

It is important to note that the use of anti-seize compounds may result in inaccurate fastening torques.

NOTE: Nylon spacers should be installed between the hub and drum assembly and the wheel center disc section.

WHEEL REMOVAL

CAUTION

Wheel and tire assemblies weight in excess of 100 pounds. Use caution while unfastening the wheel from hub, and when lifting off of studs.

NOTE: It may be necessary to drive the coach onto a run-up block, in order to gain sufficient clearance for jacking (Figure 2).

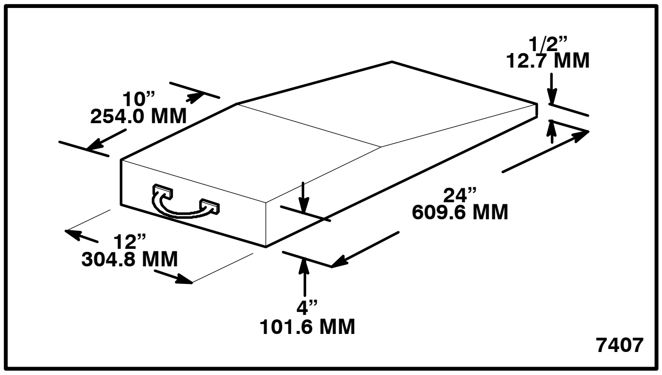


Figure 2. Run-up Block

If a flat tire occurs and wheel is to be changed, the following procedures should be followed.

Front Axle

1. Turn front wheels straight in preparation for wheel and tire removal.
2. Run flat tire up on run-up block. Stop coach and apply parking brakes.
3. Place jack under front jack pad and raise coach (Figure 3).
4. Before tire is completely off ground partially loosen wheel nuts.
5. Raise coach completely, remove run-up block and proceed to remove wheel nuts.

Drive Axle

1. If inner dual is to be changed, partially loosen the outer dual wheel nuts before running up on run-up block.

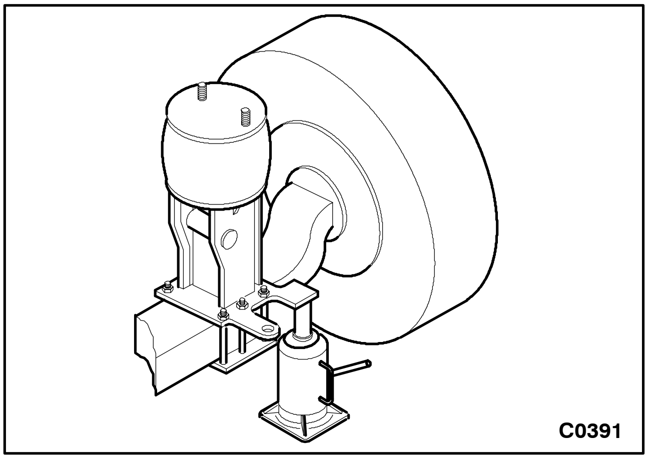


Figure 3. Front Jack Pad

NOTE: If either the inner or outer dual wheel is flat, position the run-up block in front of the inner dual and roll coach up and onto it.

2. Run flat tire up on run-up block. Stop coach and apply parking brakes.

3. If inner dual is to be changed, remove outer dual wheel nuts and remove outer wheel and tire.

4. Place jack under rear jack pad and raise coach (Figure 4).

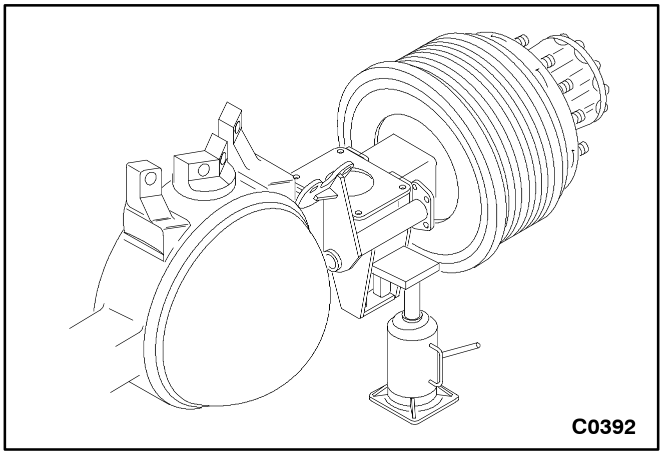


Figure 4. Rear Jack Pad

NOTE: Jack pads are located on the front of support for 102D3 models coaches, and on the rear for 102DL3 model coaches.

5. Before tire is completely off ground partially loosen wheel nuts. If inner dual is to be changed partially loosen the fluted inner wheel nuts,

6. Raise coach completely, remove run-up block and proceed to remove wheel nuts.

Trailing Axle

1. Partially loosen wheel nuts before tire is lifted off ground.

2. Place the drive axle tire on run-up block. Stop coach and apply parking brakes.

3. Place jack under rear pipe strut jack pad and raise coach (Figure 5).

NOTE: 102DL3 trailing axle jacking pads are the RH and LH lower clamp assemblies. The trailing axle may be lifted at mid point only when rear suspension air bellows are emptied.

4. Before tire is completely off ground partially loosen wheel nuts.

5. Raise wheel completely and proceed to remove wheel nuts.

NOTE: Only stud-piloted wheels are shown in the torque sequences represented. Sequences are the same for hub-piloted wheel installations.

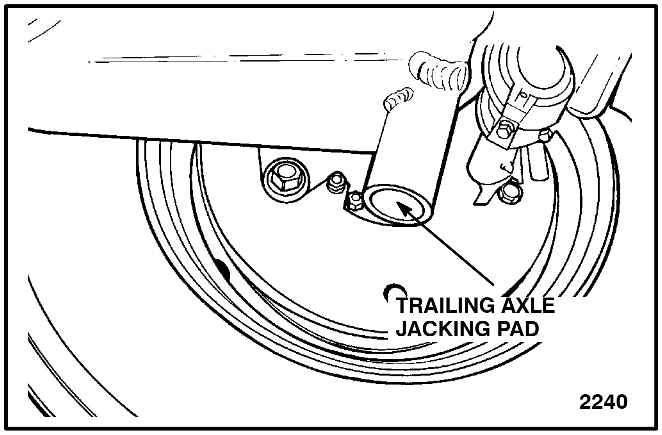


Figure 5. Trailing Jack Pad

WHEEL INSTALLATION

NOTE: When installing stud-piloted wheels with both conventional and one-piece flanged wheel nuts, always install and tighten the cone-shaped wheel nuts first to properly center the wheel.

The spare wheel and tire is stowed in a compartment immediately behind the front bumper. Access is gained by pulling bumper release handle, (located in the front left-hand service compartment), then pull bumper out and down until the hinge locks in the open position. Make sure that both bumper locks are firmly in place after closing compartment door. Run-up block is supplied in the coach tool compartment.

Front Axle

1. Place nylon spacer onto wheel stud bolt circle and mount wheel and tire on hub.

2. Moderately tighten the cone shaped nuts on stud-piloted wheel installations alternately on each side of wheel until wheel is centered.

NOTE: This should position the wheel concentrically with hub, otherwise, wheel may be eccentric with hub and may not run straight.

3. Run in all other wheel nuts and torque in sequence per the specific wheel installation torque specification (Figure 6 & 7).

4. Position run-up block under tire and lower jack. Drive coach off of run-up block and stow.

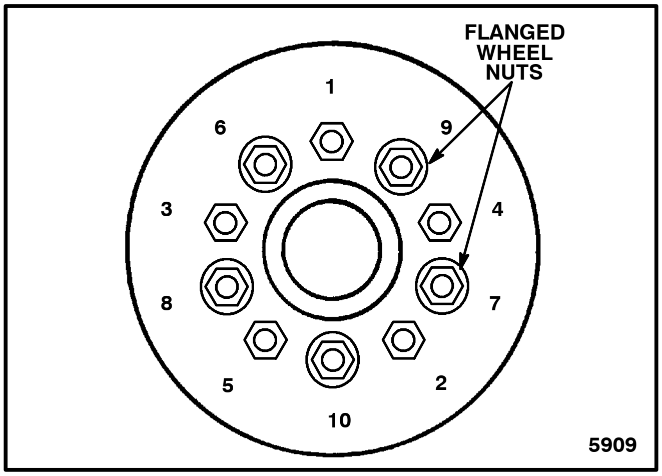

FLANGED
WHEEL
NUTS
1
6
9
3
4
8
7
5
2
10
5909

Figure 6. Front Torque Sequence (Steel)

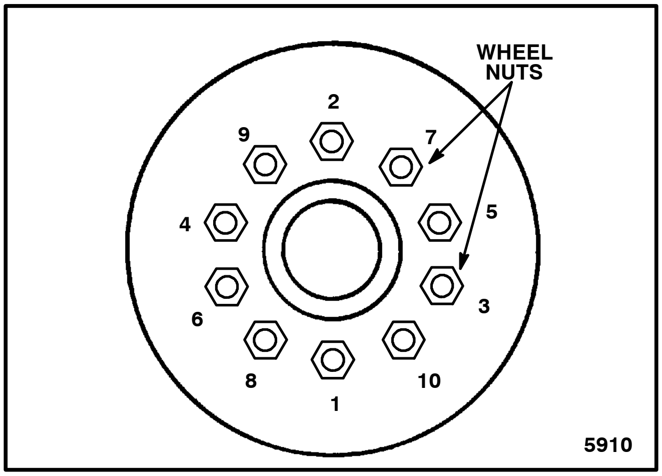

WHEEL
NUTS
2
9
7
4
5
6
3
8
10
1
5910

Figure 7. Front Torque Sequence (Aluminum)

Drive Axle

NOTE: When mounting rear dual wheels, care should be taken to position the tire valve stems 180 degrees apart so that access to both inner and outer tire valves may be obtained (Figure 8).

1. Place nylon spacer onto wheel stud bolt circle and mount inner wheel and tire on hub.

2. Moderately tighten the fluted inner wheel nuts on stud-piloted wheel installations alternately on each side of wheel until wheel is centered.

3. Torque the fluted inner wheel nuts in sequence per the specific wheel installation torque specification (Figure 9).

NOTE: Only stud-piloted wheel installations have the inner wheel nuts.

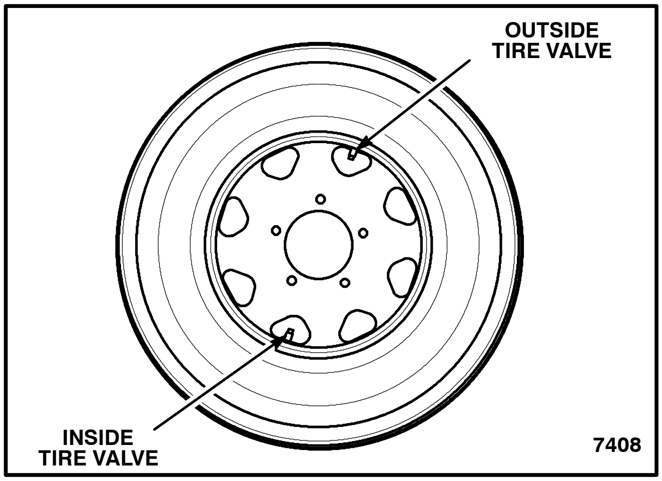

OUTSIDE
TIRE VALVE
INSIDE
TIRE VALVE
7408

Figure 8. Proper Tire Valve Position

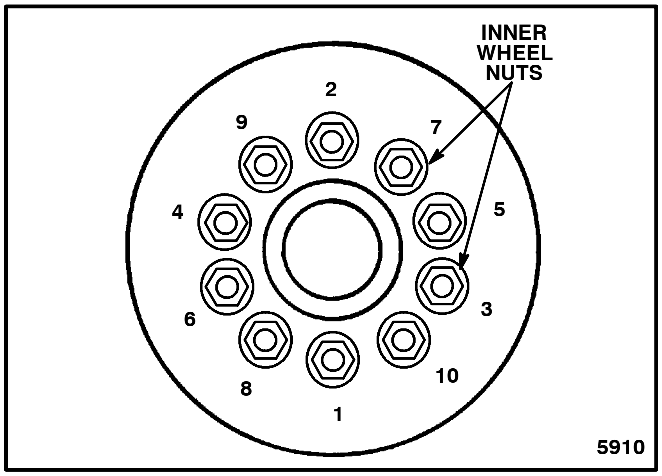

INNER
WHEEL
NUTS
2
9
7
4
5
6
3
8
10
1
5910

Figure 9. Inner Dual Torque Sequence

4. Torque the outer wheel nuts in sequence per the specific wheel installation torque specification (Figure 10).

5. Position run-up block under tire and lower jack. Drive coach off of run-up block and stow.

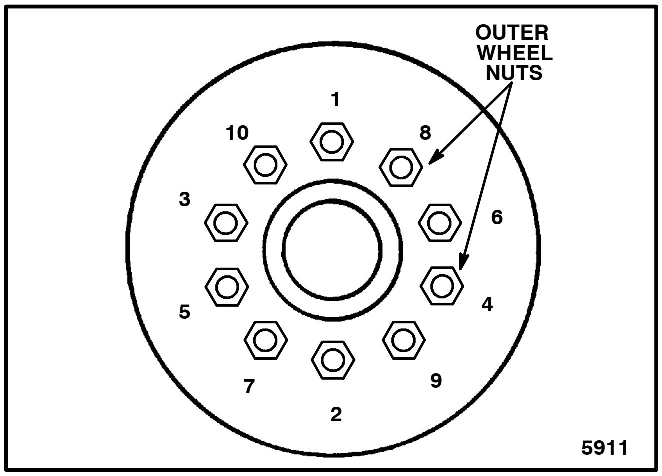

OUTER
WHEEL
NUTS
1
10
8
3
6
5
4
7
9
2
5911

Figure 10. Outer Dual Torque Sequence

Trailing Axle

1. Place nylon spacer onto wheel stud bolt circle and mount wheel and tire on hub.

2. Moderately tighten the cone shaped nuts on stud-piloted wheel installations alternately on each side of wheel until wheel is centered.

3. Torque the wheel nuts in sequence per the specific wheel installation torque specification (Figure 11).

4. Position run-up block under tire and lower jack. Drive coach off of run-up block and stow.

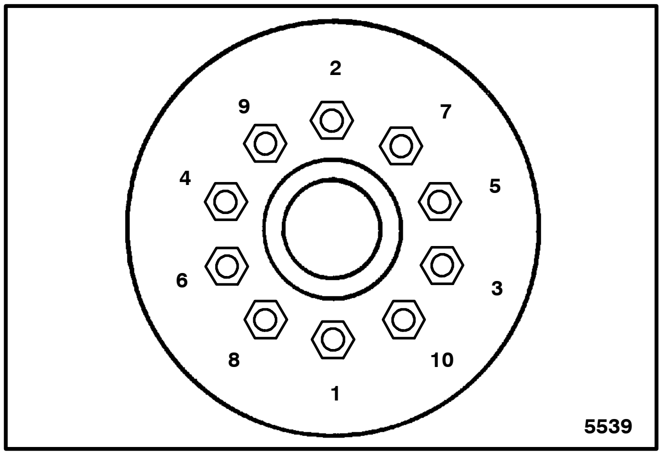


Figure 11. Trailing Axle Torque Sequence

MISCELLANEOUS TORQUE SPECIFICATIONS

Wheel Stud Rear Locknut	175-250 ft-lbs (237-339 N·m)
Front Axle Wheels (Stud-Piloted Steel)	450-500 ft-lbs (610-678 N·m)
Front Axle Wheels (Hub-Piloted Steel)	350-400 ft-lbs (474-542 N·m)
Front Axle Wheels (Stud or Hub-Piloted Aluminum)	400-500 ft-lbs (542-678 N·m)
Drive Axle Wheels (Inner and Outer Nuts) (Stud-Piloted Steel)	450-500 ft-lbs (610-678 N·m)
Drive Axle Wheels (Inner and Outer Nuts) (Stud-Piloted Steel/Alum)	450-500 ft-lbs (610-678 N·m)
Drive Axle Wheels (Inner and Outer Nuts) (Stud-Piloted Aluminum)	400-500 ft-lbs (542-678 N·m)
Drive Axle Wheels (Inner and Outer Nuts) (Hub-Piloted Steel)	350-400 ft-lbs (474-542 N·m)
Drive Axle Wheels (Inner and Outer Nuts) (Hub-Piloted Steel/Alum)	350-400 ft-lbs (474-542 N·m)
Drive Axle Wheels (Inner and Outer Nuts) (Hub-Piloted Aluminum)	400-500 ft-lbs (542-678 N·m)
Trailing Axle Wheels (Stud-Piloted Steel)	450-500 ft-lbs (610-678 N·m)
Trailing Axle Wheels (Hub-Piloted Steel)	350-400 ft-lbs (474-542 N·m)
Trailing Axle Wheels (Stud or Hub-Piloted Aluminum)	400-500 ft-lbs (542-678 N·m)

SECTION 15B

HUBS

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	15B-1
Components	15B-1
Maintenance	15B-2
Service Tools	15B-6
Specifications	15B-7

GENERAL DESCRIPTION

The coach wheels, tires, drums and/or rotors are attached directly to the hub assembly, which is a major part of the axle wheel end components. All of the axle's wheel end components are specially designed to handle axle loadings while spinning on the shaft tube or spindle. All wheel end components are lubricated by oil bath or optional grease packing. This section will detail the proper maintenance procedures that are required for all of the wheel end components.

COMPONENTS

WHEEL END ASSEMBLY

A coach wheel end assembly is made up of several components. The forged hub is machined to close tolerances for installation of seals, bearing cups, hub caps and wheel attachment studs. Front and rear cone-type roller bearings with their assorted attachment and adjusting hardware are required to properly mount the hub. The hub's inner wheel seal and front hub cap or axle shaft cover (rear axle) seal the hub to prevent lube from escaping.

HUB CAP

Front and trailing axle hubs utilize hub caps with integral sight glass. The sight glass is provided for conveniently checking oil levels. A rubber composition snap plug is provided in center of the hub cap to help in maintaining correct oil levels (Figure 1).

NOTE: Hub cap assemblies are different for disc and drum installations.

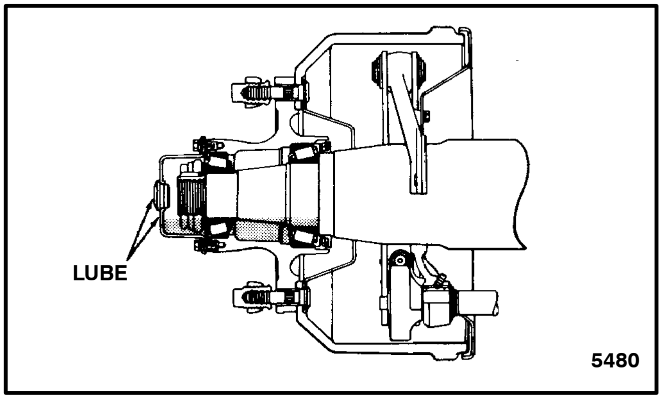


Figure 1. Sight Glass & Lube Level

BALANCED BRAKE DRUMS

Balanced brake drums are provided on all axles of the coach. Balanced drums help reduce vibrations, which can be caused by unbalanced drums. Use only balanced replacement drums.

NOTE: Machining (re-facing) of the balanced drums may require that they be rebalanced to attain the benefits of reduced vibration and improved suspension performance.

IMPORTANT: Steady or intermittent vibrations emanating from front or rear areas of coach, could indicate one or more of the following conditions:

A. Drums, wheels and tires out of balance.
B. Improper attachment of wheels or hubs.
C. Mismatched or worn tires.
D. Improperly inflated tires.
E. Coach axles out of alignment.
F. Overloaded axle or suspension system.

MAINTENANCE

NOTE: The maintenance procedures outlined in this section deal with important coach service issues. Read each procedure completely through before beginning any of the operations.

LUBRICATION

The wheel bearing lube oil levels should be checked daily. If oil is not visible at the sight gauge level mark, sufficient gear oil should be added. Use lubrication specification S-9 & S-10 – Multi-purpose Gear Oil, or S-11 &S-12 – Hypoid Gear Oil (rear axle applications).

Filling Front & Trailing Axle Hubs

1. Pry out rubber sight glass stopper plug
2. Fill hub cavity until oil appears in the lower area of the clear plastic filler's boss ring. This boss is identified by the level indicator arrow on front of filler.
3. Reinstall the rubber plug, operate coach and recheck level. Do not overfill the hubs.

Filling Rear Axle Hubs

1. Unfasten and remove the drive axle's fill plug
2. Fill until lube oil flows from the fill hole and plug.
3. Raise each axle end approximately 15 degrees to allow lube oil to enter hub cavity.
4. Recheck oil level in axle and fill if necessary. Do not overfill the hubs.

INSPECTIONS

The wheel end components should inspected every 100,000 miles for correct bearing adjustment and end play. Wheel seals should also be inspected at this time. Refer to the following removal & disassembly procedures for front, trailing and drive axle wheel end components. If any of the components require replacement, use these procedures in conjunction with the specific adjustment and replacement procedures that are detailed later in this section.

Front & Trailing Axle (Figure 2)

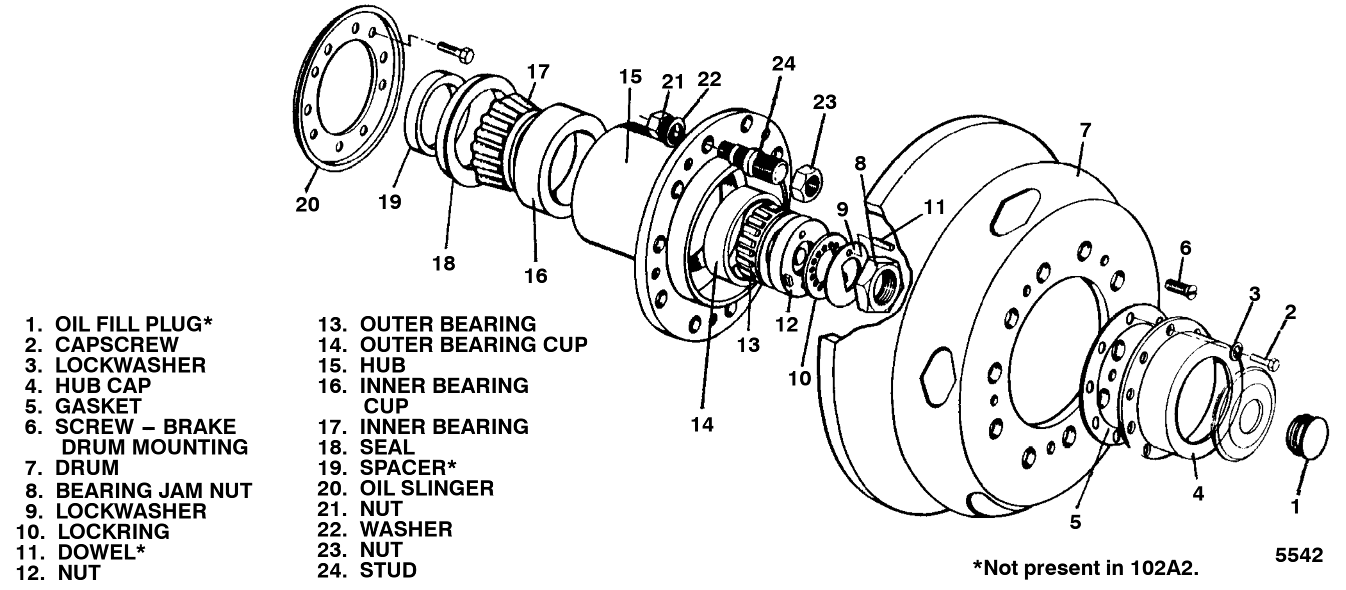
1. Block coach from moving, jack axle wheel end and remove wheel.

NOTE: Refer to section 3F of this manual for lifting or jacking points.

2. Unfasten hub retaining screws and remove brake drum.
3. Unfasten hub cap mounting screws and lockwashers (2 & 3), and remove the hub cap (4) and gasket (5).

NOTE: Check for proper bearing adjustments at this time. If bearing are to be replaced or seal inspection is to be performed, continue with procedure.

4. Bend up the tang on locking washer (9). Unfasten and remove jamnut (8), locking washer and lock ring (10). Unfasten and remove bearing adjusting nut (12).

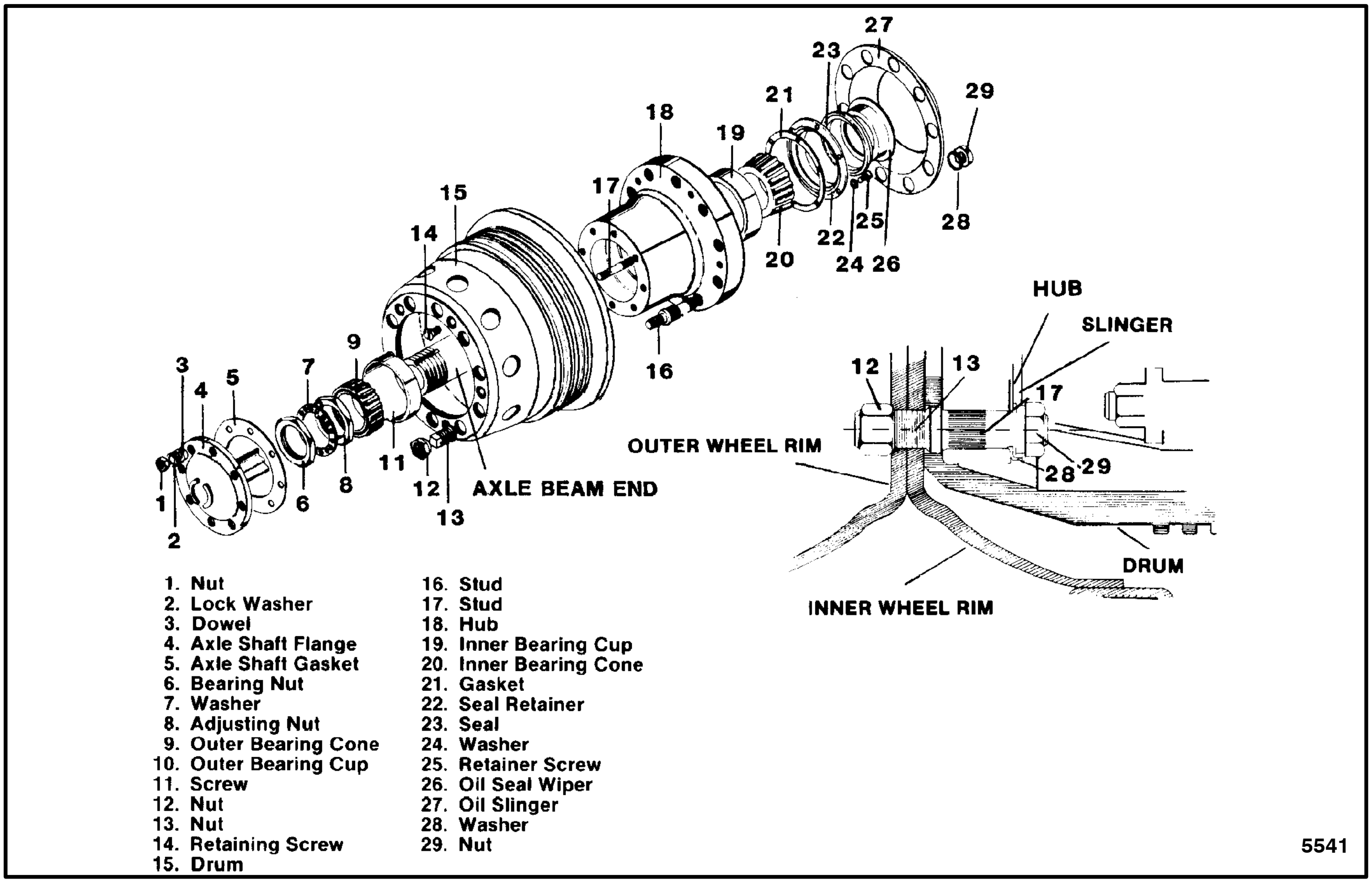


1. OIL FILL PLUG*
2. CAPSCREW
3. LOCKWASHER
4. HUB CAP
5. GASKET
6. SCREW – BRAKE DRUM MOUNTING
7. DRUM
8. BEARING JAM NUT
9. LOCKWASHER
10. LOCKRING
11. DOWEL*
12. NUT
13. OUTER BEARING
14. OUTER BEARING CUP
15. HUB
16. INNER BEARING CUP
17. INNER BEARING
18. SEAL
19. SPACER*
20. OIL SLINGER
21. NUT
22. WASHER
23. NUT
24. STUD

*Not present in 102A2.

5542

Figure 2. Front and Trailing Hub and Drum.



1. Nut
2. Lock Washer
3. Dowel
4. Axle Shaft Flange
5. Axle Shaft Gasket
6. Bearing Nut
7. Washer
8. Adjusting Nut
9. Outer Bearing Cone
10. Outer Bearing Cup
11. Screw
12. Nut
13. Nut
14. Retaining Screw
15. Drum
16. Stud
17. Stud
18. Hub
19. Inner Bearing Cup
20. Inner Bearing Cone
21. Gasket
22. Seal Retainer
23. Seal
24. Washer
25. Retainer Screw
26. Oil Seal Wiper
27. Oil Slinger
28. Washer
29. Nut

Figure 3. Drive Axle Hub and Drum

5. Remove outer cone bearing (13), and pull the hub assembly off the spindle. Use care to avoid damage to the seal assembly.

6. Remove inner cone bearing (17).

7. Clean all the hub parts in a suitable cleaning solvent, using a stiff brush to remove old lubricant and dirt. Using similar methods, clean any dirt or other build-up from the spindle's seal area.

8. Inspect the spindle and hub bore for nicks and burrs, removing any that are found with an emery cloth or file.

9. Inspect the bearings for excessive wear, deterioration, cracking, scoring or pitting on the bearing cups, rollers or cones. If present, the bearings should be replaced following the "Bearing Cup Replacement" procedure.

10. When inspecting wheel seals, look for wear, deterioration, distortion, or damage at the sealing surfaces. Replace any damaged or defective seals using the "Seal Replacement" procedure.

⚠ CAUTION ⚠

The tire, wheel, hub and drum assemblies could weight over 300 pounds together. When making seal inspections, and to prevent any seal damage from occurring, always remove the tire and wheel from hub or use an approved tire dolly.

11. Reassemble and mount components in reverse order and perform a bearing adjustment.

12. Reinstall hub cap using new gasket and lockwashers. Torque screws to 20-30 ft-lbs (27-41 N·m).

13. Check brake shoe pad adjustment and lubrication levels after completion of procedure. Reinstall wheel using the torques given in section 15A.

Drive Axle (Figure 3)

1. Follow steps 1 & 2 of the pervious procedure.

2. Unfasten and remove axle shaft cover mounting hex nut (1), lockwashers (2) and dowels (3). Remove the axle shaft cover (4) and gasket (5).

NOTE: Check for proper bearing adjustments at this time. If bearing are to be replaced or seal inspection is to be performed, continue with procedure.

3. Bend up the tang on locking washer (if present). Unfasten and remove jamnut (6) and lock ring (7). Unfasten and remove bearing adjusting nut (8).

4. Remove outer cone bearing (9), and pull the hub assembly off the load tube. Use care to avoid damage to the seal assembly.

5. Remove inner cone bearing (20) and any seal spacer (if present).

6. Clean all the hub parts in a suitable cleaning solvent, using a stiff brush to remove old lubricant and dirt. Using similar methods, clean any dirt or other build-up from the load tube seal areas.

7. Remove the wheel stud's hex nut and washer mounting oil singer to rear of hub and remove.

8. Unfasten and remove the seal retainer screws, retainer (mounting seal & wiper), spacer (if present) and gasket.

9. Inspect the load tube and hub bore for nicks and burrs, removing any that are found with an emery cloth or file.

10. Proceed with steps 9 thru 11 of the previous procedure.

11. Install the seal and retainer assembly onto the rear hub. Remount the slinger and torque hex nuts to 175-250 ft-lbs (237-339 N·m)

12. Reinstall axle shaft cover using new gasket and lockwashers. Torque hex nuts or capscrews to 85-115 ft-lbs (115-156 N·m).

13. Check brake shoe pad adjustment and lubrication levels after completion of procedure. Reinstall wheel using the torques given in section 15A.

WHEEL BEARINGS

IMPORTANT: Wheel seal integrity can be affected by excessive wheel bearing end play. Incorrect wheel bearing adjustments, will eventually lead to bearing and/or seal failure. When performing bearing adjustments, always inspect the condition of the wheel seal for any damage.

The following procedures are provided to properly adjust the bearings and to determine wheel bearing tolerances after adjustment.

Adjustment

1. Pry locking washer tab(s) up and off the outer hex jamnut flats (when present).

2. Remove the outer hex jamnut, lockwasher and lock-ring.

3. Torque the outer bearing's adjusting nut to 100 ft.lbs. (136 N·m) while rotating the hub. This assures proper contact of all bearing surfaces.

4. Back the adjusting nut off 1 full turn and preload bearing by retorquing the adjusting nut while again rotating the hub as follows:

A. Preload front & trailing axle bearings to 20 ft-lbs (27 N·m).

B. Preload Drive axle bearings to 50 ft-lbs (68 N·m).

5. Back adjusting nut off as follows:

A. Back off 1/4 turn for drive axle bearings.

B. Back off 1/3 turn for front & trailing axle bearings.

6. Replace lock-ring with adjusting nut index pin inserted into one of the lock-ring holes and reinstall lockwasher.

7. Replace locking washer (when present) and bend tabs over the flats of the hex jamnut after completion of step 8.

8. Reinstall outer hex jamnut and torque as follows:

A. Torque front & trailing axle bearings to 200–300 ft-lbs (271–406 N·m).

B. Torque drive axle bearings to 250–400 ft.lbs. (339–542 N·m).

NOTE: To check the wheel bearing adjustment, refer to the "Bearing End Play" procedure at this point.

9. Rotate wheel to check final bearing adjustment. Wheel must also rotate freely within the specified end play limits.

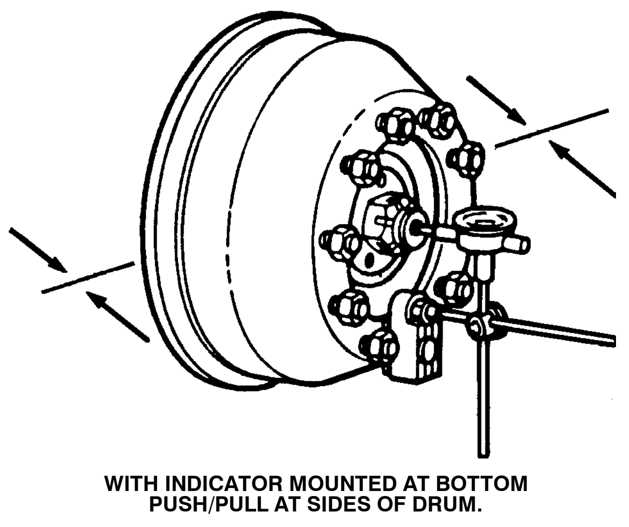


Figure 4. Dial Indicator Installed

Measuring End Play

1. Attach a dial indicator with the magnetic base at the bottom of the brake drum (Figure 4).

2. Adjust the dial indicator so the pointer is against the center of the spindle and the axis of each are parallel. Set the dial indicator to zero.

3. To measure the wheel end play, observe the dial indicator while pushing/pulling on each side of the brake drum. End play is the total travel observed and should be within the following range:

A. End play range for front & trailing axle bearings is .001-.005 inches (.025−.127 mm).

B. End play range for drive axle bearings is .001-.010 inches (.025−.254 mm).

NOTE: These end play ranges is based on using pre-lubricated bearings.

4. If the measurement is not within this range, repeat the wheel bearing adjustment procedure.

5. When the wheel bearing end play measurement is satisfactory, remove the dial indicator and reassemble wheel end components.

Bearing Cup Replacement

1. Where possible remove the old bearing cup (race) by knocking it out from opposite end of hub. A long steel drift or punch works well.

2. Clean and inspect the bearing cup bore. Remove any nicks or burrs that may prevent new cup installation with a small high speed grinder, file or emery cloth.

3. Place the hub on a flat surface and properly locate new cup over bore.

4. Using the old bearing cup, gently tap new cup into its bore. This procedure sets the cup and prevents cocking. A press can then be used to fully install the bearing cup after it has been started.

5. Turn hub over and repeat procedure for remaining bearing cup.

6. Reassemble wheel end components and perform a bearing adjustment.

WHEEL SEALS

Several different styles and sizes of wheel seals are utilized on the various 102D Series coach axles. In addition, the wheel seal designs can vary from one manufacturer to another. When replacing seals, always specify the OEM product.

IMPORTANT: MCI recommends that seals be properly installed by using only the seal manufacturer's prescribed installation tools. The use of these tools assure correct placement of the seal. Improper installation procedures or the use of out dated tools could cause seal damage or premature failures in some of the newer wheel seal designs utilized on todays coach axles.

NOTE: Seals installation tools generally consist of a handle assembly (with spacer/adapter, washer and hex nut), seal tool (seal specific) and bearing centering tool. These tools may be purchased through the seal manufacture.

Seal Replacement

1. With the hub positioned on a flat surface, carefully pry old seal out of its bore or out of the retainer (drive axle only).

2. Clean and inspect this bore for any nicks or burrs that may prevent new seal installation. Remove these with a small high speed grinder, file or emery cloth.

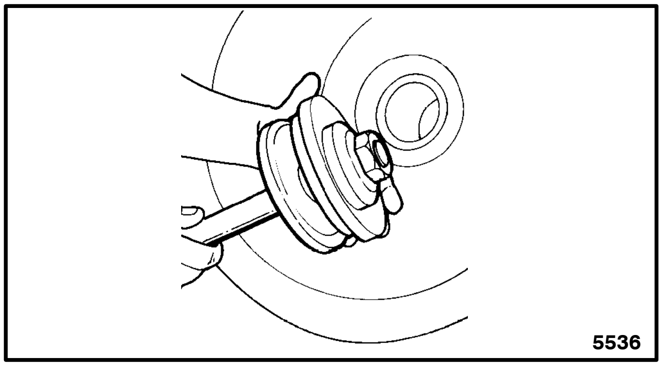


Figure 5. Seal and Adapter on Tool Rod

3. Assemble the seal installation tool with the proper bearing centering tool installed.

NOTE: Inner bearing cup and cone bearing must be in place to properly center seal installation tool.

4. Set smaller O.D. of seal in recess of tool adapter (Figure 5).

5. Properly locate the new seal over bore by inserting bearing centering tool into inner bearing race. The centering tool prevents cocking of the seal in the bore (Figure 6).

6. Hold tool handle firmly and strike with hammer until seal is fully seated in bore.

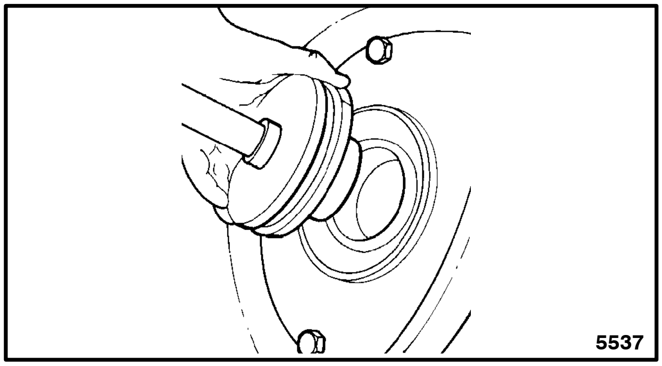


Figure 6. Installing Tool With Seal in Hub

NOTE: The sound of impact should change as seal bottoms out.

7. After seal is installed, check for freedom of movement by inserting fingers and moving interior rubber component of seal backward and forward.

NOTE: A slight movement indicates damage free installation

8. Reassemble the wheel end components and perform a bearing adjustment.

Wear Sleeves

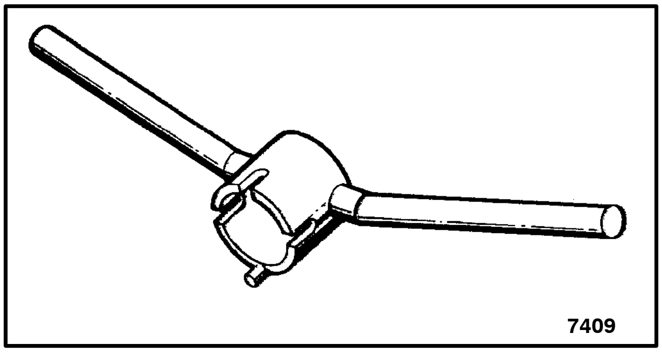
Seal wear sleeves (wipers) are installed on the drive axle and newer model coach trailing axle assemblies. The sleeves can be replaced when seal wear has become deep enough to allow lubricant to weep through.

Front axle and older model trailing axle spindle seal surfaces which have been evaded can be repaired by the installation of a shaft repair sleeve. These repair sleeves are generally provided by the seal manufacturer.

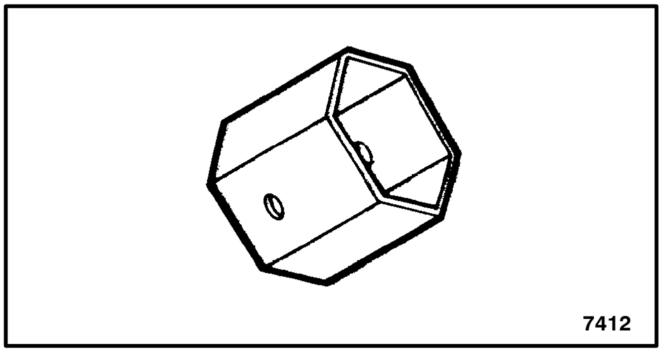
NOTE: During inspections check the areas on which the seal rides (seal track). If you can catch your fingernail in a seal track or detect a groove, a new sleeve should be installed.

SERVICE TOOLS

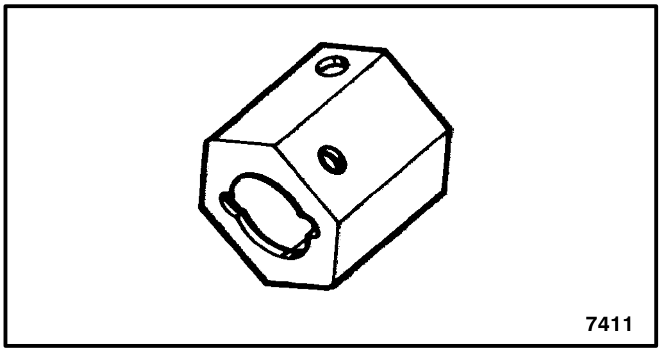
SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



20-56 Wrench - Front/Trailing Bearing Adjusting Nut



20-168 Wrench - Rear Main Axle Bearing & Lock Nut



20-167 Wrench - Front & Tag Axle Nut

SPECIFICATIONS

BEARINGS (DRUM BRAKES)

Part Number (Front Inner)	15J-2-4 (Bearing) 15C-2-25 (Cup)
Part Number (Front Outer)	15C-2-14 (Bearing) 15-2-504 (Cup)
Part Number (Drive Inner)	15J-3-15 (Bearing) 15J-3-4 (Cup)
Part Number (Drive Outer)	15C-3-17 (Bearing) 15-3-112 (Cup)
Part Number (14.5 x 5 Trailing Inner)	15C-2-13 (Bearing) 15-3-112 (Cup)
Part Number (14.5 x 5 Trailing Outer)	15C-2-14 (Bearing) 15-3-504 (Cup)
Part Number (15 x 4 Trailing Inner)	15L-5-5 (Bearing) 15L-5-27 (Cup)
Part Number (15 x 4 Trailing Outer)	15A-2-39 (Bearing) 15L-5-28 (Cup)

BEARINGS (DISC BRAKES)

Part Number (Front & Trailing Inner)	15L-5-5 (Bearing) 15L-5-27 (Cup)
Part Number (Front & Trailing Outer)	15A-2-39 (Bearing) 15L-5-28 (Cup)

SEALS (DRUM BRAKES)

Part Number (Front Inner)	15R-2-9
Part Number (Drive Inner)	15J-3-11
Part Number (14.5 x 5 Trailing Inner)	15J-2-18
Part Number (15 x 4 Trailing Inner)	15L-2-21

SEALS (DISC BRAKES)

Part Number (Front Inner)	15L-2-4
Part Number (Trailing Inner)	15L-5-21

SECTION 15C

TIRES

CONTENTS OF THIS SECTION

SUBJECT PAGE

General Description 15C-1
Maintenance 15C-1
Specifications 15C-6

GENERAL DESCRIPTION

The D Series coaches use special inter-city bus and coach tires designed for on-highway service. These tires are generally steel-belted, and have load range ratings of ”H” or better. Standard size tires used are 12.75 x 22.5 mounted on 8.25 x 22.5 rims. Radial ply metric tire sizes are also available for use.

MAINTENANCE

There are many variables which can effect tire performance and wear. Improper inflation, Improper balance, improper coach ride height, improper alignment, exceeding load limits and/or speeds, sharp cornering, etc.. are just a few examples which have a direct relationship on tire performance and wear.

The correct maintenance procedure is essential to safe and economical tire service. Daily tire inspection procedures should be used to carefully inspect for cuts or foreign matter such as nails, glass, etc. Remove any foreign matter lodged between tires and dual wheels.

INFLATION

Check tire inflation pressure with an accurate gauge. Pressure should be checked before starting a run and should be as recommended by tire manufacturer. Always use the same gauge to check the pressure to eliminate any differences resulting from gauge error (Figure 1).

If pressure loss is greater than normal, remove and inspect tire to determine cause. Replace any missing valve caps.

NOTE: Tire pressure should be checked with pressure cold.

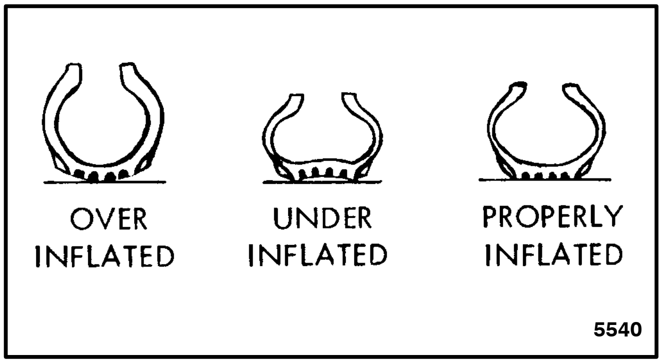


Figure 1. Tire Inflation

The valve core is a spring loaded check valve in the stem permitting inflation or deflation of the tire. The valve is provided to seal the air in the tire. When the valve cap is tightened on the stem, the sealing washer inside the cap is pressed tightly against the top of the stem, preventing air leakage.

Axle configurations will dictate specific tire pressures. Improper inflation is the greatest cause of accelerated tire wear. Tires should be checked frequently for this condition. Unless correct air pressure is consistently maintained, tires will not function as they should; consequently, safe, economical operation of the coach will be affected.

An underinflated tire runs sluggishly, heats up quickly because of greater flexing, and is subjected to more frequent bruising. Overinflation does not compensate for overloading. It does not add strength to the tire; in fact, it actually weakens the tire by reducing its ability to absorb road shock, and may cause a blowout.

In addition to the effect improperly inflated tires may have on tire life, improperly inflated tires will degrade steering, riding comfort, and safe driving.

All tires on the same axle should always carry the same air pressure. A difference in air pressure between rear tires and front tires may be permissible within certain limitations; however, there should not be a difference in pressures between the right and left tires on the same axle. A 5 psi (34.5 kPa) underinflation in one front tire not only can cause hard steering, but can create steering hazards which may cause unsafe operation. An underinflated rear tire can seriously affect braking. Balance tire pressures for steering ease, riding comfort, driving safety, as well as for minimum fuel consumption and maximum tire mileage.

Recommended inflation pressures are shown below and in the tables at the end of this section.

102DL3

FRONT	115 PSI (COLD)
DRIVE	95 PSI (COLD)
TRAILING	95 PSI (COLD)

102D3

FRONT	105 PSI (COLD)
DRIVE	85 PSI (COLD)
TRAILING	75 PSI (COLD)

REPLACEMENT

CAUTION

Always replace tires with the same size tire as originally came with coach. Failure to do this may result in poor engine and transmission performance due to incorrect road speed input into electronic control systems.

When tires are changed, especially to the new low profile tires now available, clearances and revolutions per mile may be affected. Before making changes to tires with different specifications, ensure that the replacement tires have adequate clearances and that the revolutions per mile are not seriously affected.

Customers who have already changed to replacement tires, especially to low profile tires, should check to ensure that the tires are not rubbing and that the revolutions per mile have not affected the speedometer reading.

ROTATION

NOTE: Before rotating tires, consult the tire manufacturer. They are the source for directions relating to specific tires.

Radial tires should be rotated only when necessary. If the tires are wearing evenly, there is no need to rotate. If irregular wear becomes apparent, or if the wear rate on the tires is perceptively uneven, the tires should be rotated in such a manner to alleviate the problem. There is no restriction on crisscross rotation.

Bias-ply tires should be interchanged at regular intervals to obtain maximum life. Change wheels without dismounting tires so direction of rotation will be reversed. The following system of interchanging is recommended: Right front to left rear inside or right rear outside. Left front to right rear inside or left rear outside.

If inside dual tires show more wear than outside dual tires, place front tires on inside when changing. In this case, outside dual tires can be interchanged between right and left side of vehicle.

If outside dual tires show more wear than inside dual tires, place front tires on outside dual tires when changing. At the same time, interchange right and left hand inside dual tires.

New tires should be installed on front wheels where they run coolest. Baggage should always be placed as far to the rear as possible. This puts the load on the rear axle and reduces front tire stress.

Safety Precautions

WARNING

Exercise care when handling wheels and tires. careful attention to the following suggestions will prevent injury. Make it a rule to respect the explosive force contained in an inflated tire.

1. Prepare for any tire repair operation in a proper way. In servicing tires be careful not to drop them on the feet, hands or body, or heavily on the floor. Practice proper methods of lifting. When carrying tires or wheels, avoid oil and objects on the floor. Keep floor clean and dry (Figure 2).

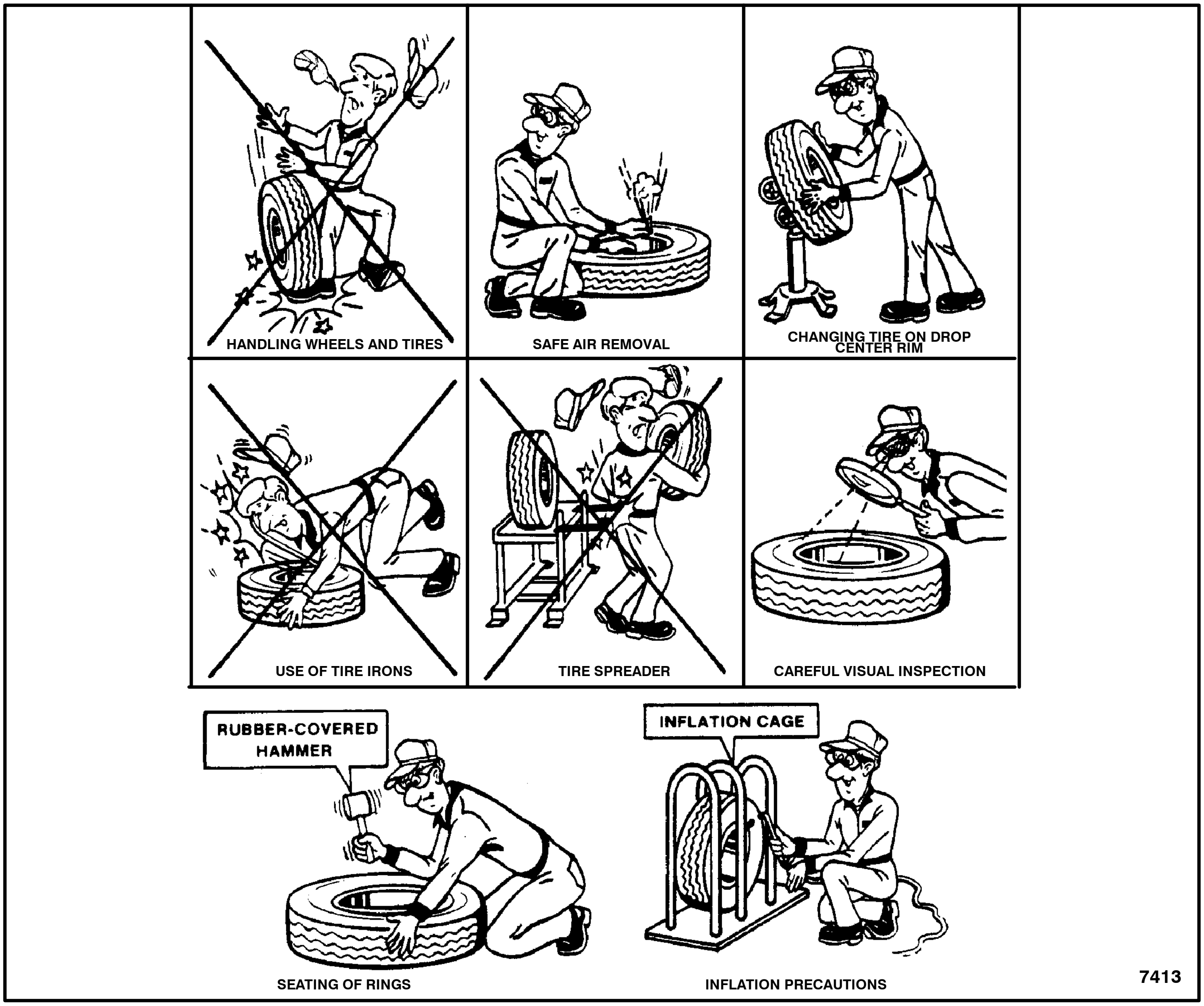

HANDLING WHEELS AND TIRES
SAFE AIR REMOVAL
CHANGING TIRE ON DROP CENTER RIM
USE OF TIRE IRONS
TIRE SPREADER
CAREFUL VISUAL INSPECTION
RUBBER-COVERED HAMMER
INFLATION CAGE
SEATING OF RINGS
INFLATION PRECAUTIONS
7413

Figure 2. Safety Precautions

2. Deflating a tire properly is very important. First reduce pressure as much as possible by pushing the valve core plunger. Keep your eyes away from valve. Remove valve core to ensure complete deflation. Wear approved safety glasses or goggles when using compressed air.

3. Dismounting tires from wheels requires special care. Tires on drop center rims are best handled on a wheel holder, or tire changing machine. This will prevent cuts on hands and wrists and will make it unnecessary to use a mallet for seating the tire. Use only standard tire mounting tools and equipment. Use of makeshift tools, screwdrivers, or pliers to force tires on or off rims or wheels is dangerous.

4. Use special care when using tire irons. Grip them firmly and keep them free of oil and grease. They can slip and fly with tremendous force.

5. After removal, a careful inspection of the tire should be made and all necessary repairs performed. A tire spreader is helpful but use care when working around it. Keep spreader arms closed when machine is idle.

6. Inspect wheel parts carefully for rust, damage, or distortion. Never use wheels which are out of shape, rusted, cracked or broken in any way. Never use a ring or other rim parts of different manufacturers than the original rims or any different size or type. Tires or rims often require a buffing operation before mounting after repairs are made. Always wear safety glasses or a face shield when buffing tires or rims.

7. Avoid hammering on wheels with steel hammers. Small bits of steel may break off hammer or rim and fly into eyes, face, or body. Use rubber covered, steel-headed hammers whenever possible.

8. Stand away from valve stem as far as possible when inflating tires. Avoid a position where the face or body is immediately over the work being done on any tire in which there is pressure. Use only accurate, tested gauges to ensure proper air pressure.

Manual Tire Changing

NOTE: This procedure applies only to tires on dismountable rims. Tools required: Two (2) tubeless tire tools, One (1) pair vise-grip pliers, lubricant and brush. Use only rims free from damage, rust or pitting.

⚠ CAUTION ⚠

Avoid using any lubricants (soaps) which contain compounds injurious to rubber.

DISMOUNTING

1. Deflate tire completely by removal of valve stem.
2. With tire lying flat, loosen both beads by walking on tire with heels close to rim.

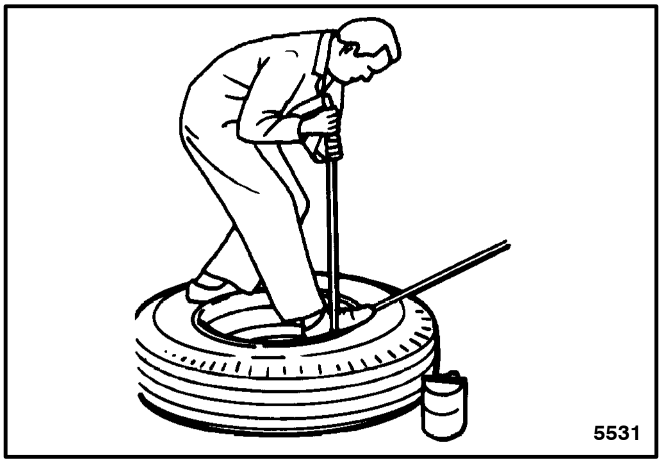


Figure 3. Pulling First Tool Toward Center

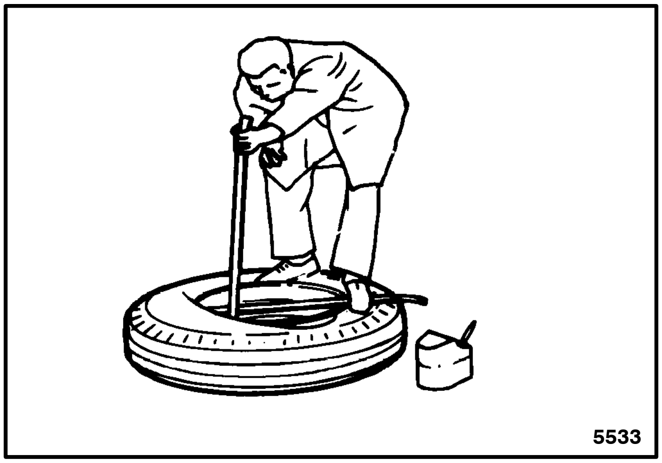


Figure 4. Second Tool Toward Center

3. With wide side of rim down, lubricate top bead.
4. With stops toward rim, insert spoon ends of both tools about 10 inches (254 mm) apart.
5. Holding bead in well with foot, pull one tool toward center of rim (Figure 3).
6. Hold tool in position with one foot and pull second tool toward center of rim. Progressively work bead off rim, taking additional bites as necessary (Figure 4).
7. Stand assembly in vertical position. Lubricate second bead.
8. At top of assembly insert straight end of tool between bead and back flange of rim at about a 45 degree angle. Turn tool so that it is perpendicular to rim. Pry second bead off (Figure 5).

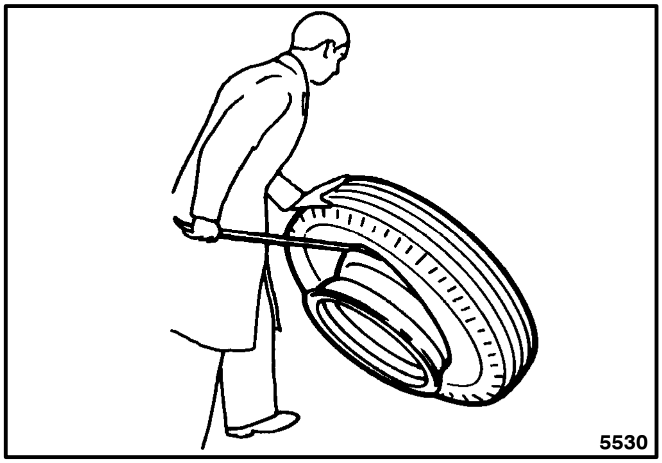


Figure 5. Prying Off Second Bead

MOUNTING

1. Be sure correct valve is used and is properly installed in the rim. Inspect rim to ensure bead seats are clean and smooth.
2. Place rim on floor with side down and lubricate first bead of tire and upper bead seat of rim (Figure 6).

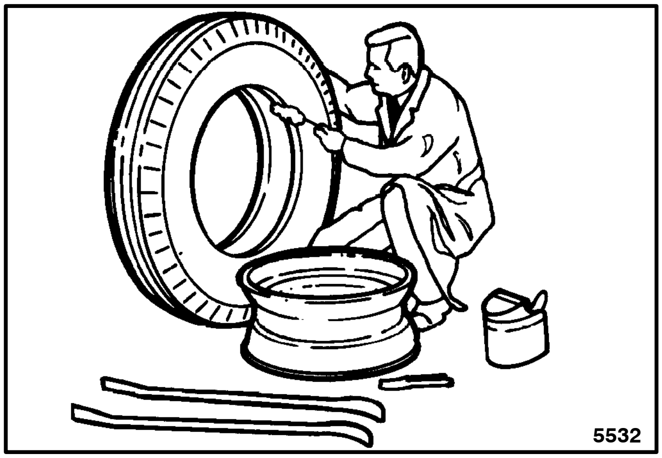


Figure 6. Applying Lubricant

3. Push first bead into well of rim and onto rim as far as possible.

4. Using straight end of tool (with stop resting on rim flange), take small bites to work remaining section of first bead on to rim (Figure 7).

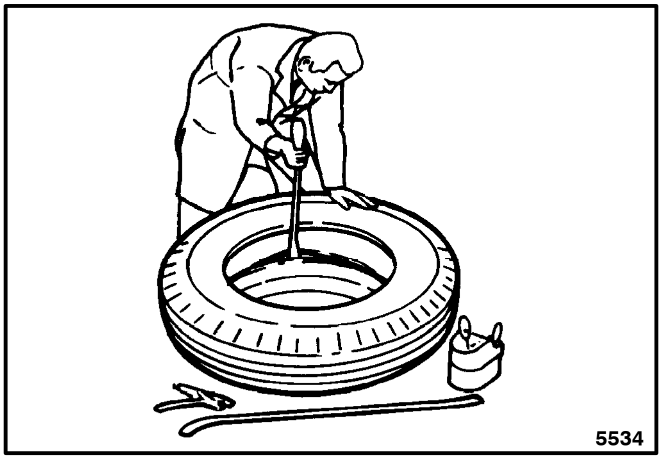


Figure 7. Installing First Bead On Rim

5. Hold second bead in well by standing on tire and anchor with vise-grip piers (snub side toward tire).

6. Using spoon end of tire tool with stop toward rim, take small bites until bead slips over flange. If necessary, insert second tire tool and lubricate last 6 inches (152 mm) of bead before completely mounting (Figure 8). Inflate tire to recommended pressure. Examine valve assembly occasionally to avoid leaks.

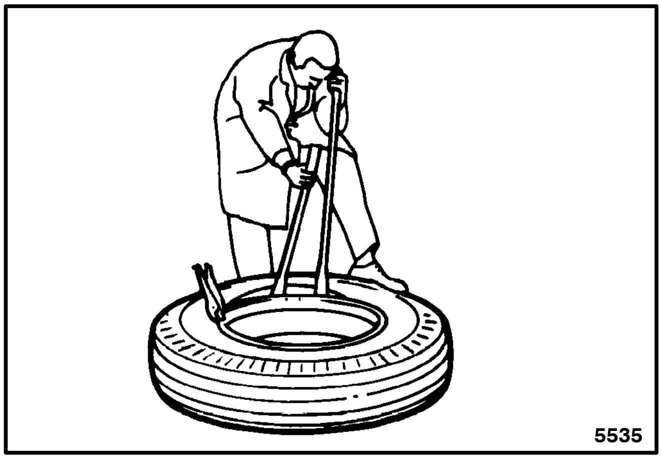


Figure 8. Installing Second Bead

ISO RATINGS

ISO ratings are the maximum load that a tire can carry at the speed indicated by the speed symbol.

ISO Rating	ISO Rating	ISO Rating	Speed Symbol
141/5677 lbs.	146/6615 lbs.	151/7607 lbs.	B=50 MPH
142/5843 lbs.	147/6780 lbs.	152/7827 lbs.	C=60 MPH
143/6008 lbs.	148/6945 lbs.	153/8048 lbs.	D=65 MPH
144/6174 lbs.	149/7166 lbs.	154/8268 lbs.	E=70 MPH
145/6394 lbs.	150/7386 lbs.	155/8544 lbs.	F=80 MPH

GROSS VEHICLE WEIGHT RATINGS

GVWR (102DL3)	44,400
Front Axle GAWR	14,400
Drive Axle GAWR	26,000
Trailing Axle GAWR	12,000
GVWR (102D3)	44,400
Front Axle GAWR	14,400
Drive Axle GAWR	26,000
Trailing Axle GAWR	N/A

SPECIFICATIONS

MANUFACTURER	GOODYEAR	GOODYEAR	GOODYEAR	GOODYEAR	FIRESTONE	FIRESTONE
TREAD PATTERN	RADIAL MILER	UNISTEEL G159	UNISTEEL II	UNISTEEL II	HP 3000	HP 3000
SIZE	B305/75R22.5	12R22.5	12R22.5	12.75R22.5	12R22.5	*315/80R22.5
TMC PART NUMBER						15J-1-9
LOAD RANGE	“J” PR 18	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“J” PR 18
ISO RATING						
MAX. RATING	7610 LBS	7200 LBS	7200 LBS	7700 LBS	7200 LBS	8270 LBS
(SINGLE)	@120 PSI	@120 PSI	@120 PSI	@115 PSI	@115 PSI	@120 PSI
MAX. RATING	6940 LBS	6320 LBS	6320 LBS	6750 LBS	6320 LBS	7160 LBS
(DUAL)	@120 PSI	@110 PSI	@110 PSI	@105 PSI	@105 PSI	@120 PSI
REV’S / MILE	510	486	488	485	486	488
INFLATION PRES	AXLE: FRT/DR/TAG 115/95/75		AXLE: FRT/DR/TAG 120/90/80	AXLE: FRT/DR/TAG 105/85/75	AXLE: FRT/DR/TAG 115/90/80	AXLE: FRT/DR/TAG 105/85/75

* DO NOT USE FIRESTONE HP 3000 TIRES IN SIZE 315/80R22.5 ON 96” WIDE COACH.

MANUFACTURER	MICHELIN	MICHELIN	MICHELIN	BRIDGESTONE	BRIDGESTONE	BRIDGESTONE
TREAD PATTERN	XZA	XM-S4	PXZA	R180	R290	M716
SIZE	12R22.5	12R22.5	295/80R22.5	12R22.5	12R22.5	12R22.5
TMC PART NUMBER	15G-1-33	15G-1-18				
LOAD RANGE	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16
ISO RATING	150/146		150/146			
MAX. RATING	7390 LBS	7390 LBS	7390 LBS	7200 LBS	7200 LBS	7200 LBS
(SINGLE)	@115 PSI	@115 PSI	@110 PSI	@120 PSI	@120 PSI	@120 PSI
MAX. RATING	6610 LBS	6610 LBS	6610 LBS	6320 LBS	6320 LBS	6320 LBS
(DUAL)	@115 PSI	@115 PSI	@110 PSI	@110 PSI	@110 PSI	@110 PSI
REV’S / MILE	487	485	501	493	491	489
INFLATION PRES	AXLE: FRT/DR/TAG 115/95/70					
102A2/96A2 INFLATION PRES	AXLE: FRT/DR 115/90					

SPECIFICATIONS (Contd.)

MANUFACTURER	BRIDGESTONE	SUMITOMO	KELLY SPRING	SUMITOMO	TOYO	TOYO
TREAD PATTERN	M711	ST718	ARMORSTEEL KSR	ST727	M-84LA	M-87
SIZE	12R22.5	12R22.5	12R22.5	12R22.5	12R22.5	12R22.5
TMC PART NUMBER			15J-1-23			
LOAD RANGE	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16
ISO RATING						
MAX. RATING	7200 LBS	7200 LBS	7200 LBS	7200 LBS	7200 LBS	7200 LBS
(SINGLE)	@120 PSI	@120 PSI	@ 120 PSI	@ 120 PSI	@120 PSI	@120 PSI
MAX. RATING	6320 LBS	6320 LBS	6320 LBS	6320 LBS	6320 LBS	6320 LBS
(DUAL)	@110 PSI	@110 PSI	@110 PSI	@110 PSI	@110 PSI	@110 PSI
REV’S / MILE	484	491	486	491	491	491
INFLATION PRES			AXLE: FRT/DR/TAG 120/90/80			

MANUFACTURER	YOKOHAMA	HANKOOK	TIRE & RIM ASSOCIATION RECOMMENDATIONS			
TREAD PATTERN	793R	RIB F20	BIAS PLY	RADIAL	RADIAL	
SIZE		12R22.5	12-22.5	12R22.5	12.75R22.5	12.5 - 22.5
TMC PART NUMBER						
LOAD RANGE	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16	“H” PR 16
ISO RATING						
MAX. RATING	7200 LBS	7200 LBS	7200 LBS	7200 LBS	7200 LBS	7200 LBS
(SINGLE)	@ 120 PSI	@120 PSI	@115 PSI	@ 120 PSI	@ 120 PSI	@ 15 PSI
MAX. RATING	6320 LBS	6320 LBS	6320 LBS	6320 LBS	6320 LBS	6320 LBS
(DUAL)	@110 PSI	@110 PSI	@105 PSI	@110 PSI	@ 110 PSI	@ 105 PSI
REV’S / MILE	491					
INFLATION PRES			AXLE: FRT/DR/TAG 115/80/65	AXLE: FRT/DR/TAG 120/90/70	AXLE: FRT/DR/TAG 105/80/60	AXLE: FRT/DR/TAG 115/75/60
102A2/96A2 INFLATION PRES			AXLE: FRT/DR 115/90	AXLE: FRT/DR 120/95	AXLE: FRT/DR 105/80	AXLE: FRT/DR 115/80

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 16

HEATING AND AIR CONDITIONING

This section consists of four primary subsections. Select the subsection that covers the information required. Then turn to the subsection index for a complete listing of subjects covered. Tool information will be found after the appropriate subsection.

The primary subsections are:

A - Heating System
B - Air Conditioning & Ventilation
C - Air Conditioning Compressor
D - Auxiliary Heater (Series 60)

SECTION 16A

HEATING SYSTEM

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	16A-1
Components	16A-1
Operation	16A-6
Maintenance	16A-9

GENERAL DESCRIPTION

The D series coach incorporates a hot-water forced-air heating system utilizing circulated engine coolant. Heated coolant, generated by the combustion process, is distributed throughout the system. Fresh and recirculated air is used to heat the coach interior.

The heated coolant is pumped, by the engine's water pump, through supply and return lines to the main and secondary heating coil assemblies (Figure 1). Air is then forced over the coils and through the HVAC's supply and return ducts. The 102D series coach heating system capacities are as follows: 156,000 BTU/hr main system, and 36,000 BTU/hr secondary (driver's) system.

> **NOTE:** The new engine installations may require using auxiliary heating sources as described in Subsection 16D to help augment heat requirements in some areas.

The coach's interior heating and defrosting system is automatically regulated by thermostatic controllers The heating system's components are designed to be operated either separately, or together with the other HVAC system components.

COMPONENTS

The heating system's major components are the digital thermostatic temperature controllers, main heating coil, the main two-speed blower, the secondary (driver's) heating coil, the three-speed defroster blowers, the main hot water stop valve, the secondary (driver's) hot water stop valve, the auxiliary heater assembly (when used), and miscellaneous sensor probes, cables, switches and control devices (Figures 2 & 3).

The components of the main heating system (i.e., blower and heating coil) are located in the main HVAC module in front of baggage bay #3. The same components of the secondary (driver's) heating system are located inside the driver's defroster/evaporator/heater module located under the right-hand dash assembly.

TEMPERATURE CONTROLLER

Digital function temperature controllers (thermostats) are used on the coach to automatically monitor and control passenger and driver area temperatures. The main (passenger) thermostat is mounted in the instrument panel, while the driver's unit is mounted in a pocket attached to the inside junction box cover (Figure 4). The controllers regulate temperatures by opening or closing the main or driver's hot-water stop valves.

These controllers have a digital readout feature which shows the current temperatures, and a rotary set point selector knob. The unit is calibrated in either degrees Fahrenheit or degrees Celsius. It controls the coach temperature within 3°F (1.72°C). Temperature selection range is 65-85°F (18°-29°C). Each click of the rotary switch is equal to 2°F . The reference mark on the controller face is equal to 72°F. Each controller is connected to an ambient and interior temperature sensing probe. The controllers are powered through the keyed ignition or master run switch. Wiring connections to the heating system components are shown in Section 7J.

HEATING COIL ASSEMBLY

The heating coils are assembled adjacent to and as an assembly with the air conditioning evaporator coils in both the main and secondary HVAC systems. The coil assemblies are copper tube with aluminium fins. Both coil assemblies incorporate a purge valve for venting air from the system.

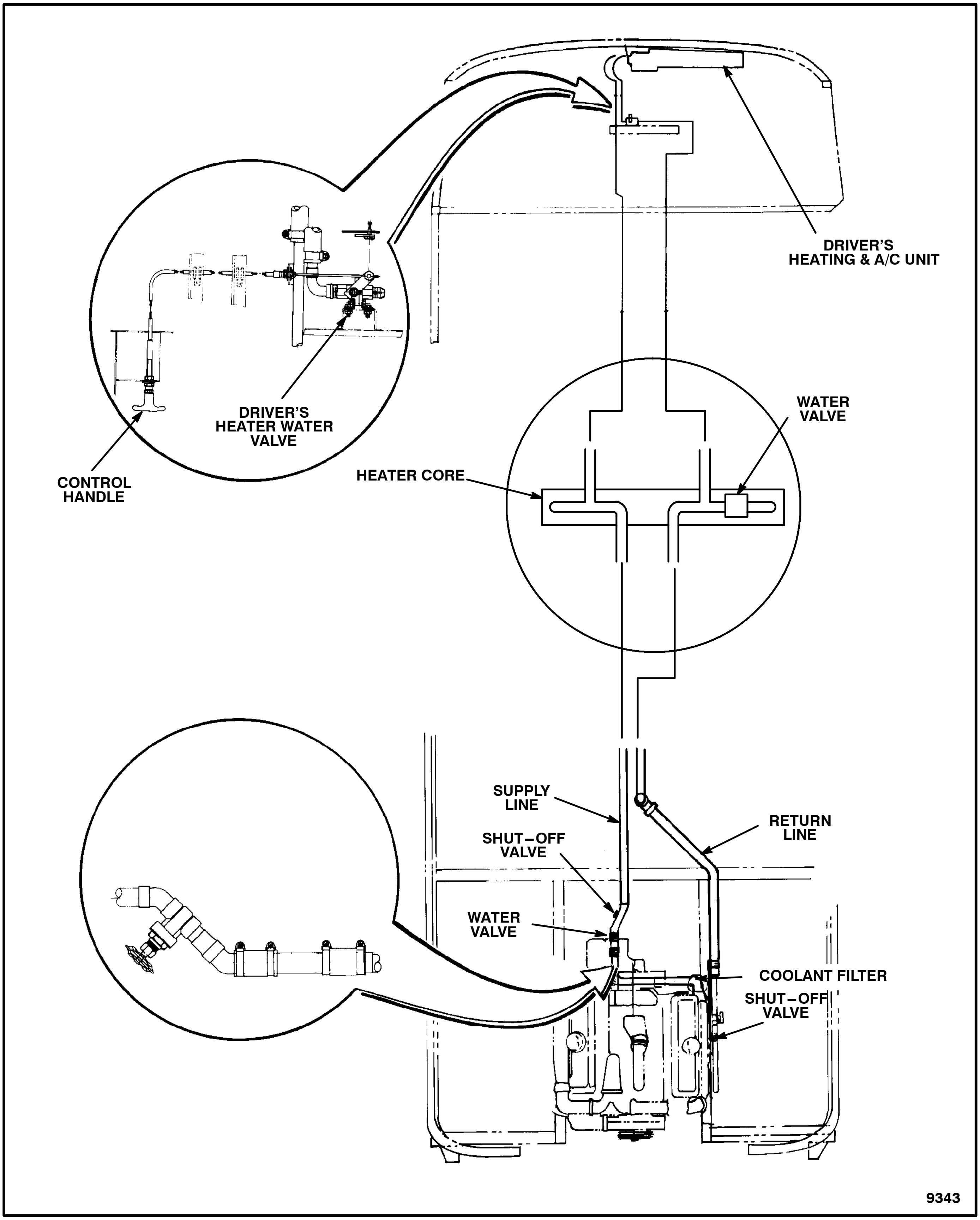

DRIVER'S HEATING & A/C UNIT
WATER VALVE
HEATER CORE
DRIVER'S HEATER WATER VALVE
CONTROL HANDLE
SUPPLY LINE
SHUT–OFF VALVE
WATER VALVE
RETURN LINE
COOLANT FILTER
SHUT–OFF VALVE
9343

Figure 1. Heating System Distribution

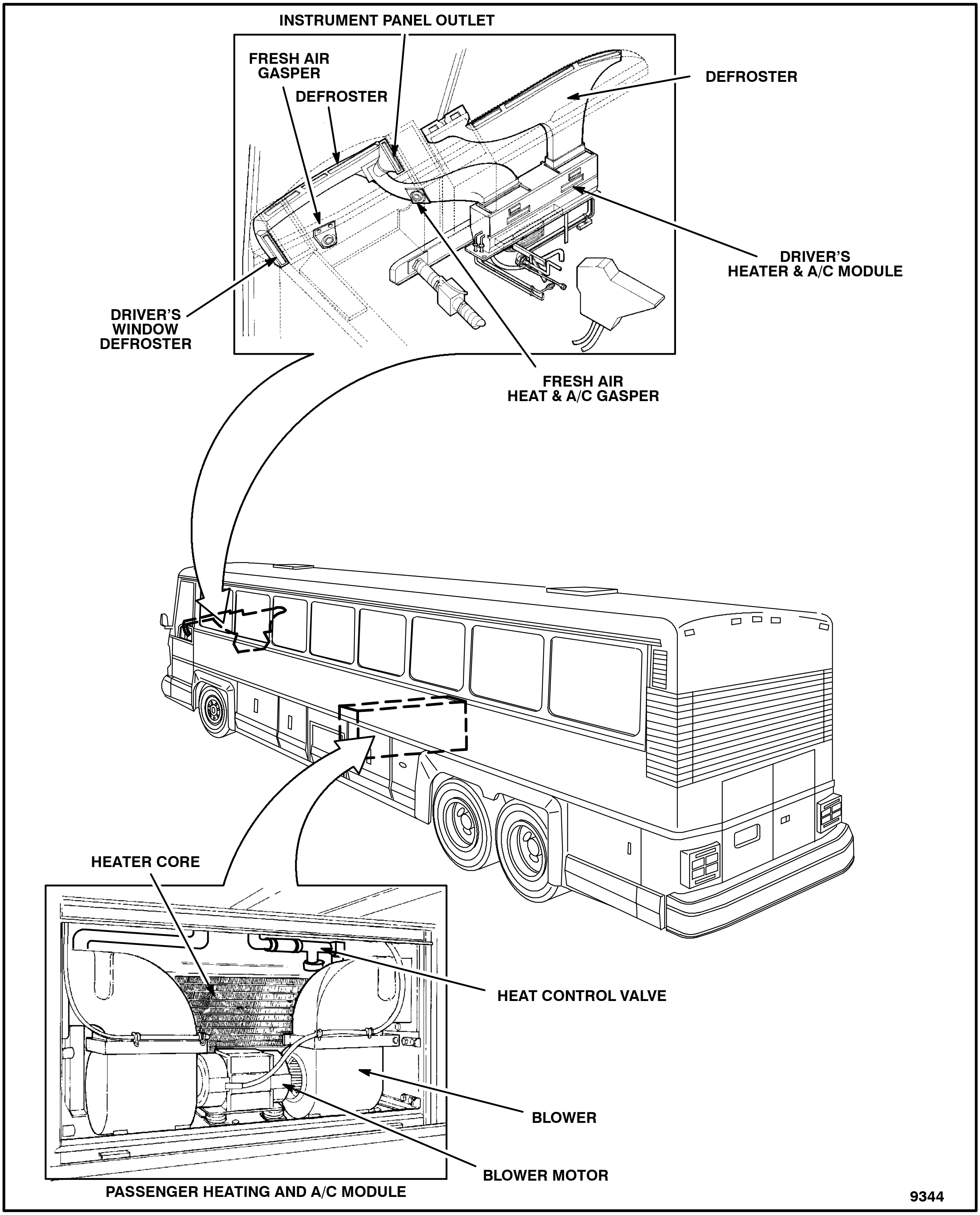

INSTRUMENT PANEL OUTLET
FRESH AIR GASPER
DEFROSTER
DEFROSTER
DRIVER'S HEATER & A/C MODULE
DRIVER'S WINDOW DEFROSTER
FRESH AIR HEAT & A/C GASPER
HEATER CORE
HEAT CONTROL VALVE
BLOWER
BLOWER MOTOR
PASSENGER HEATING AND A/C MODULE
9344

Figure 2. Heating System Major Components

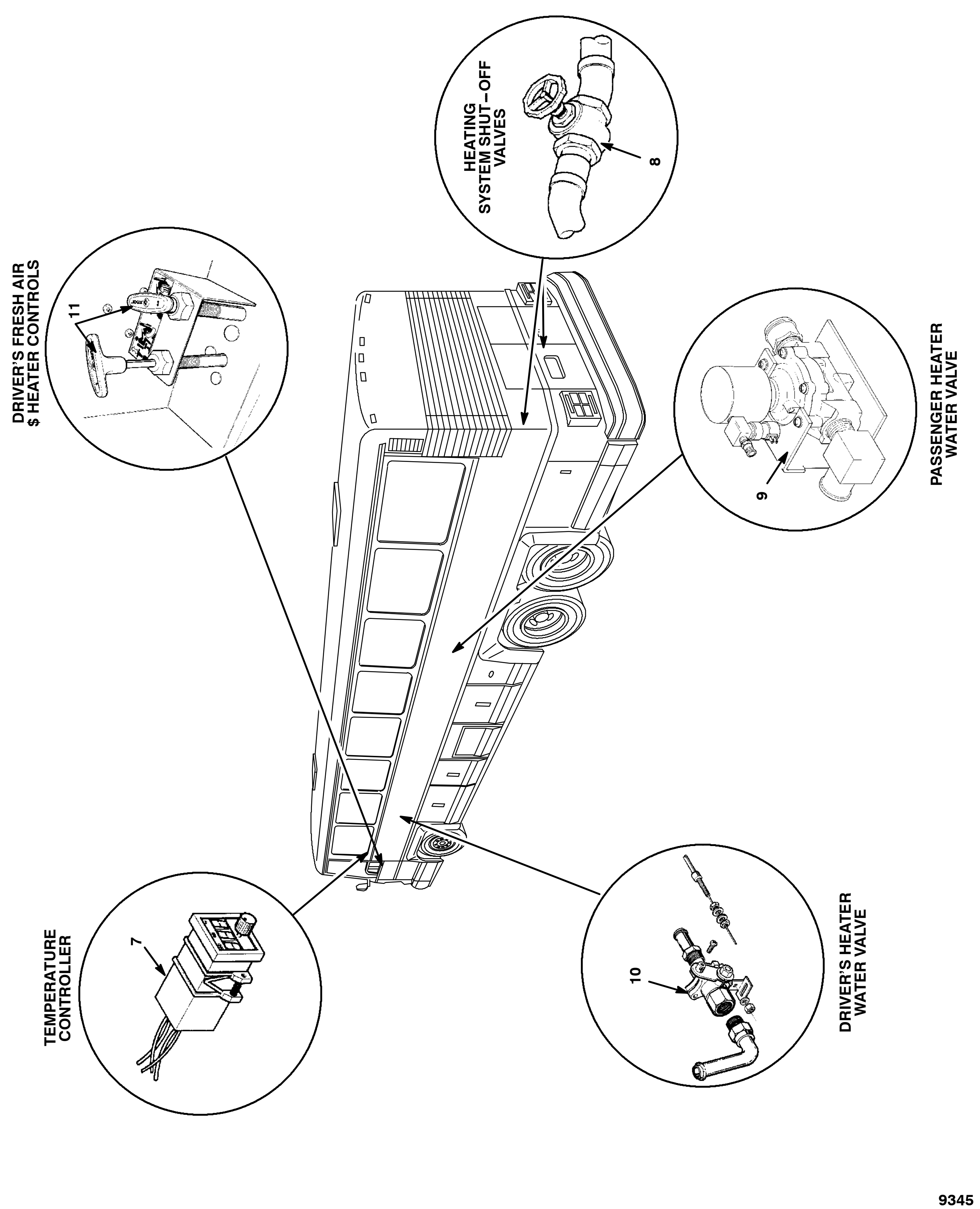

HEATING SYSTEM SHUT–OFF VALVES
8
DRIVER'S FRESH AIR $ HEATER CONTROLS
11
PASSENGER HEATER WATER VALVE
9
TEMPERATURE CONTROLLER
7
DRIVER'S HEATER WATER VALVE
10
9345

Figure 3. Heating/Air Conditioning System

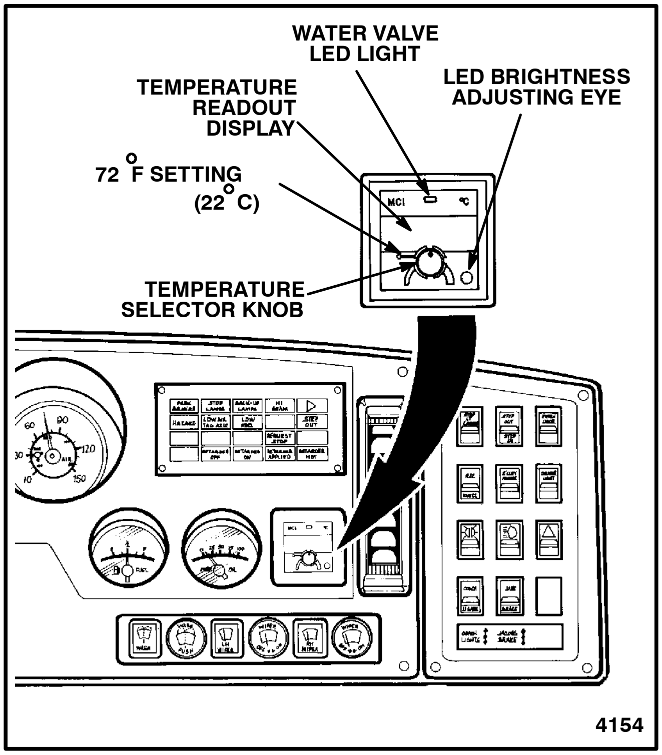


Figure 4. Temperature Controller

BLOWER ASSEMBLY

Main Passenger Blower

The main HVAC blower assembly is a twin centrifugal type design, mounting a two-speed 24-volt twin-shaft 1-1/2 hp (1.1 kw) motor (Figure 5). The two-speed blower assembly is located inside the main evaporator compartment, and controlled by the “High/Low” blower switch located on the upper left-hand switch panel.

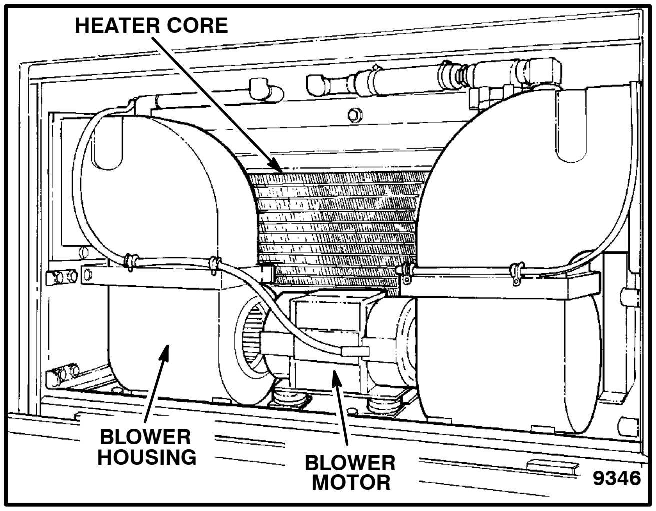


Figure 5. Main Blower Assembly

Secondary Driver’s Blower

The dual three-speed blowers of the secondary system are of the centrifugal type design, and assembled inside the driver’s module. Their operation is manually controlled by the 4-position defroster switch.

Additionally, the blower assemblies of the main and secondary heating systems are also utilized by the air conditioning function. The secondary HVAC system is also utilized for defrosting both the windshield and driver’s window. Detailed information on the defroster system can be found later in this section.

HOT-WATER VALVE ASSEMBLY

Main Valve

The passenger area hot-water stop valve is located inside the main evaporator compartment. This normally open-type valve is air-actuated and electrically controlled. In auxiliary heater applications there is an additional bypass stop valve located in the engine compartment on the auxiliary heater/engine bypass line. The bypass valve is closed by relay when main valve is open.

Secondary Valve (Prior To 47071)

The driver area hot-water valve is located in the tire compartment. This hot-water stop valve is a manually operated cable-actuated ball valve. The cable is attached at the front of the driver’s foot rest mount bracket. Unlock and pull the cable to open valve, push down to close.

Secondary Valve (Effective With 47071)

The new driver area normally open hot-water valve is also located in the tire compartment and solenoid operated. This newer valve also incorporates a filter screen in the valve inlet, which will require servicing.

TEMPERATURE PROBES

The ambient and interior temperature sensing probes are connected to the controller. The interior probe is located under the third passenger seat (street side) from the rear of the coach (Figure 6). The driver’s interior temperature probe is located under the steering column or in the RH console. The ambient temperature sensing probes for both controllers are located in the front side service compartment. The probes, together with the temperature controller, maintain the desired coach temperature in each area.

NOTE: Effective with unit 48187 the driver’s temperature probe was relocated to the RH driver’s console.

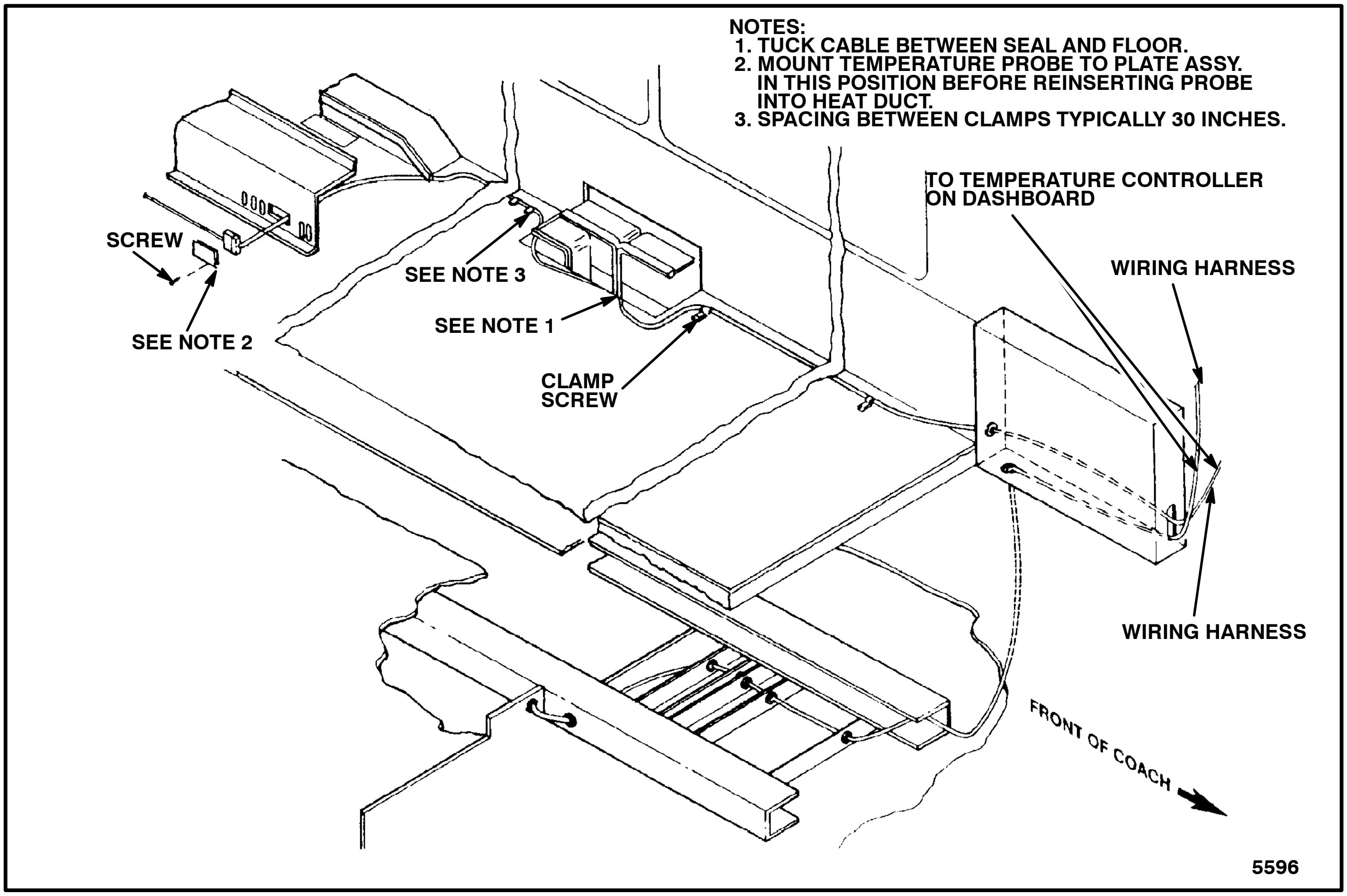

NOTES:
1. TUCK CABLE BETWEEN SEAL AND FLOOR.
2. MOUNT TEMPERATURE PROBE TO PLATE ASSY. IN THIS POSITION BEFORE REINSERTING PROBE INTO HEAT DUCT.
3. SPACING BETWEEN CLAMPS TYPICALLY 30 INCHES.
TO TEMPERATURE CONTROLLER ON DASHBOARD
WIRING HARNESS
SCREW
SEE NOTE 3
SEE NOTE 1
SEE NOTE 2
CLAMP SCREW
WIRING HARNESS
FRONT OF COACH
5596

Figure 6. Temperature Probe in Interior Distribution Duct

OPERATION

HEATING (NORMAL)

Main Heating System

When heat is required in the passenger compartment (main heating coil) the “Heat/AC” switch is positioned to “Heat”. This switch is energized through the “Blower Discharge Relay”, and completes the circuit to the two-speed blower motor’s relays inside the A/C junction box, and main HVAC compartment which starts the blower’s.

NOTE: Blower operation is interlocked with “Low Air Pressure” switch by way of the “Blower Discharge Relay” at the rear junction box.

The main hot-water stop valve’s relay, inside the temperature controller, should energize when the controller’s “heat-on” setting has been reached. This opens the valve, allowing hot water to flow through and out of the main coil. When heat is no longer needed, simply reposition the “Heat/AC” switch to “Off” position.

NOTE: The red LED light on the controller unit will be illuminated as long as the water valve is in its open position.

Secondary (Driver’s) Heating System

When heat is required in the driver’s compartment, the “Heat/AC” switch is again positioned to “Heat” as previously described. Next, the driver’s temperature controller must be adjusted to open the solenoid valve allowing hot water to flow through the coil..

NOTE: Prior to unit 47071 the driver’s heater was operated through a cable actuated hot-water stop valve.

The secondary heater/defroster incorporates dual three-speed blowers controlled by the four-position “Defroster Blower Motor Control” switch at the lower right-hand corner of the upper left-hand switch panel.

NOTE: For economy the driver’s ram air feature can be used in place of the heater/defroster blowers.

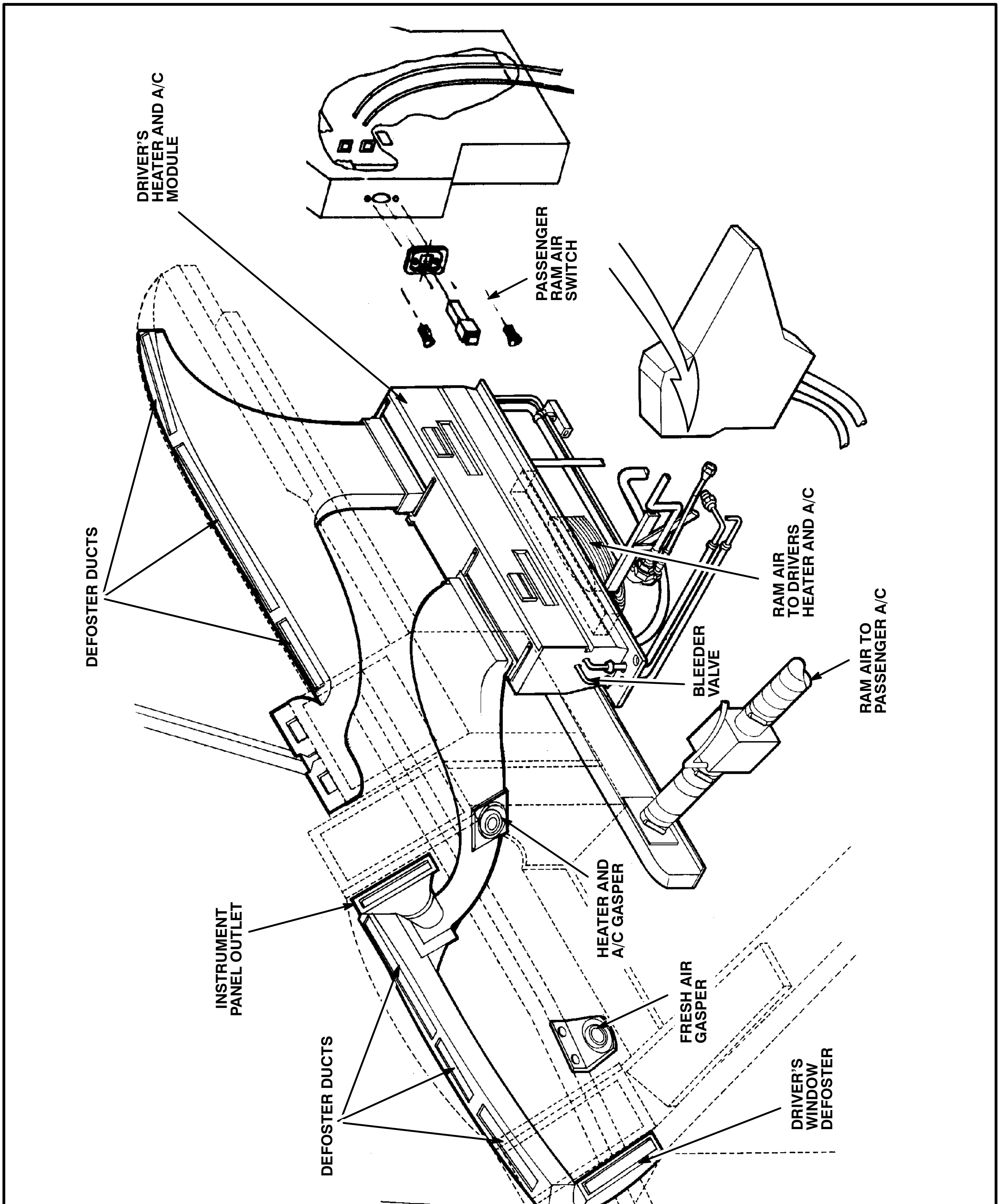
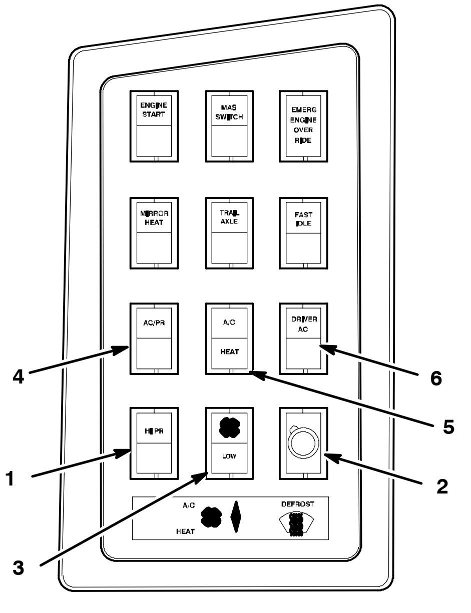

DRIVER'S HEATER AND A/C MODULE
PASSENGER RAM AIR SWITCH
DEFOSTER DUCTS
RAM AIR TO DRIVERS HEATER AND A/C
BLEEDER VALVE
RAM AIR TO PASSENGER A/C
HEATER AND A/C GASPER
INSTRUMENT PANEL OUTLET
FRESH AIR GASPER
DEFOSTER DUCTS
DRIVER'S WINDOW DEFOSTER
9347

Figure 7. Heating & Defrost System



1. PARCEL RACK 2–SPEED BLOWER SWITCH
2. DRIVER'S HEATER/DEFROSTER 3–SPEED BLOWER SWITCH
3. PASSENGER (MAIN) A/C 2–SPEED BLOWER SWITCH
4. PARCEL RACK A/C (ON/OFF) SWITCH
5. PASSENGER (MAIN) HEAT (ON/OFF) SWITCH
6. DRIVER'S HEAT (ON/OFF) SWITCH

C1248

Figure 8. Switch Locations

HEATING (W/AUXILIARY HEATER)

Main and Secondary

When heat is required in the passenger (main) or driver's (secondary) compartment the Heat/AC switch is positioned to "Heat". This energizes the auxiliary heater relay, and allows the digital timer/control switch to be operated. An indicator light should signal that the heater is operating. Heat function can now be independently directed by each of the electronic controllers.

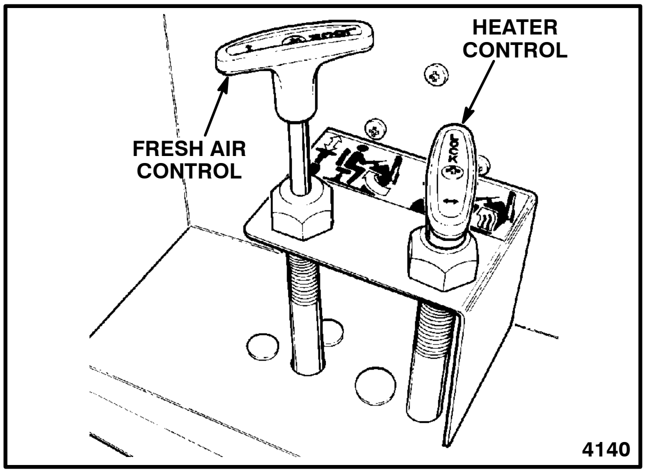


Figure 9. Driver's Fresh Air and Heater Controls

Although the heater may begin operations, no heated coolant will enter the coach's heating system coils until the thermostatic controller's "heat-on" set point has been reached. Once the setting is attained the controller's circuit, powered through the master run switch, energizes its internal water valve relay. When energized the main and driver's heater water valves should open, and the bypass water valve should close, by way of a secondary relay.

NOTE: Heat/AC switch circuit and temperature controller circuit are independent of each other.

DEFROST SYSTEM

The driver's heating system also features a separate defrost function. Heated air produced by the operation of the secondary driver's heating system can be used for defrosting the front windshields and driver's window (Figure 7).

The driver's heater/defroster's dual three-speed blowers can be set for any of the three speeds by the four-position defroster blower motor control switch. The switch is located on the upper left-hand switch panel (Figure 8).

NOTE: For economy, the driver's ram air feature can be used in place of the heater/defroster blowers.

RAM AIR (DRIVER'S FRESH AIR)

A fresh air control cable is attached to a damper inside the driver's heater/defroster/air conditioning module. The damper controls the amount of fresh air allowed to be mixed with heated recirculated air in the driver's area. The cable is located on the mounting bracket at the rear of the driver's foot rest. Unlock and push the cable down to open valve, pull up to close. Cable can be locked in either open or closed positions (Figure 9).

MAINTENANCE

The maintenance requirements for heating system components are minimal. The internal components of the heating system (i.e., coils, supply and return piping) have been designed for long life. To help guarantee trouble free service, anti-corrosion additives should be consistently used within the cooling system. Follow all of the service procedures in the order in which they appear.

HOT WATER VALVE ASSEMBLY

Main Valve

The main electrically operated and air-assisted hot-water stop valve is a spring loaded piston type valve (Figure 10). The valve is the normally open-type valve. Movement of the piston actuates the water valve's stem, opening or closing the valve. The valve is a serviceable item and can be repaired by kit.

REPLACEMENT

1. Turn main battery disconnect switch to “Off”.
2. Open and secure the main HVAC blower door panel.
3. Disconnect solenoid wiring harness and air line.
4. Unfasten the clamps securing the inlet and outlet hoses to the valve, and slide away from valve.
5. Unfasten and remove the valve from its mounting bracket, and remove the valve from compartment.
6. Mount the new valve and reattach the bracket, hoses and harness in reverse order.

REPAIR

1. Clamp valve gently in a vise, and remove air inlet fitting and solenoid assembly.

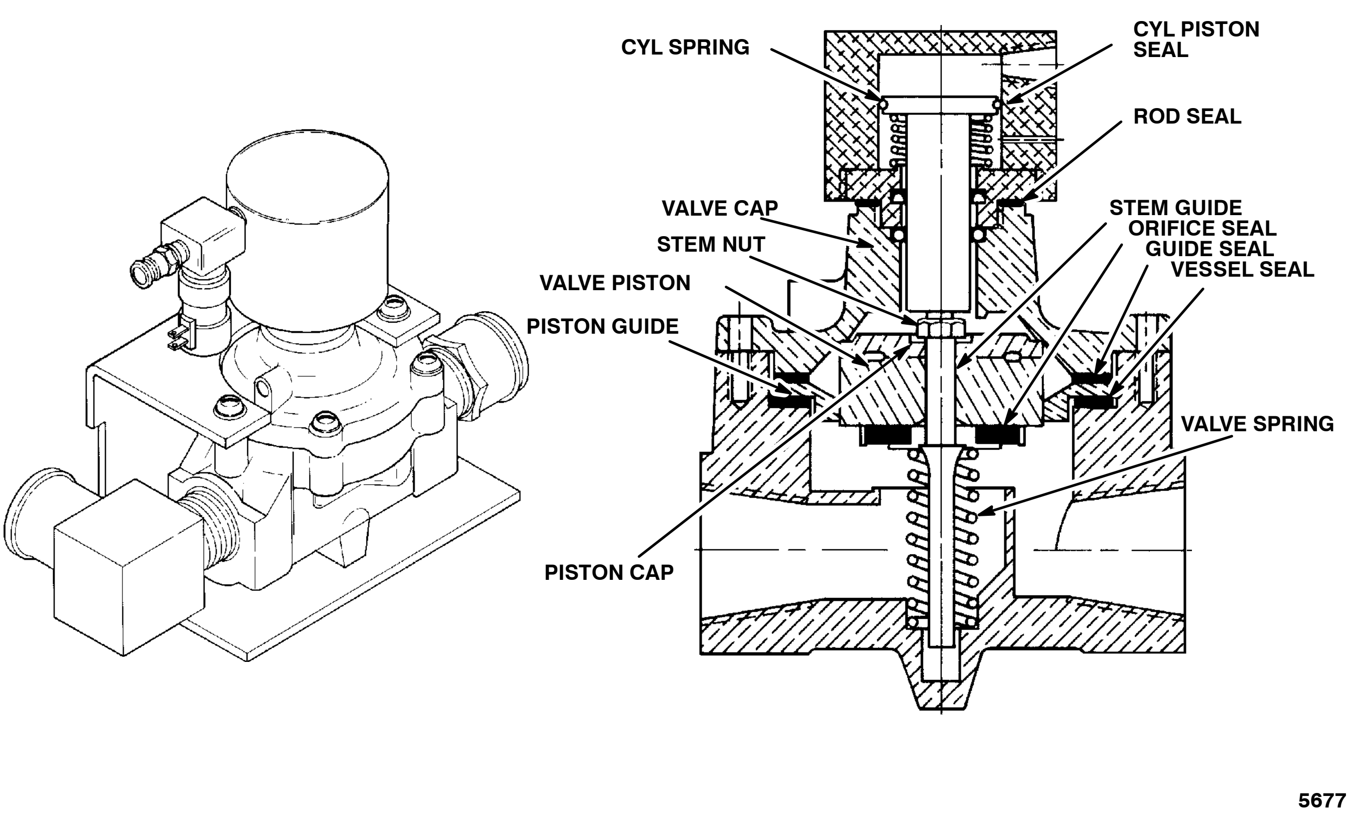


Figure 10. Main Hot-Water Stop Valve

2. Unfasten and remove air actuator and piston assembly (black cylinder at top of valve assembly) with actuator rod and piston.

NOTE: Internal cap may remain fastened to valve. If so, clamp valve and remove cap and lip seal.

3. Unfasten and remove valve bonnet from the valve’s body.
4. Remove the valve’s piston assembly with spring and stem.
5. Remove the piston’s stem nut and remove and replace seal.
6. Reassemble valve in reverse order, installing valve seals as needed. Bench test valve if possible.

Secondary (Driver’s) Valve (Electric)

The solenoid operated valve installation includes a filter screen assembly in front of valve (Figure 11). This filter should be inspected and cleaned every 100,000 miles (161,000 km), and during coolant system service or when ever heat output is noticeably below normal .

CLEANING

1. Clamp a vise grip onto hose section upstream of valve screen.

1. 16L-10-131 TUBE S/A
2. 19-10-1750 STRAINER
3. 16K-7-42 BRACKET
4. 19-10-158 ADAPTER
5. 16K-7-39 VALVE
6. 19-1-442 SCREW
7. 19-2-111 LOCKWASHER
8. 19-10-1779 ADAPTER
9. 19-10-104 ADAPTER
10. 16L-10-636 TUBE
11. 19-10-448 ELBOW

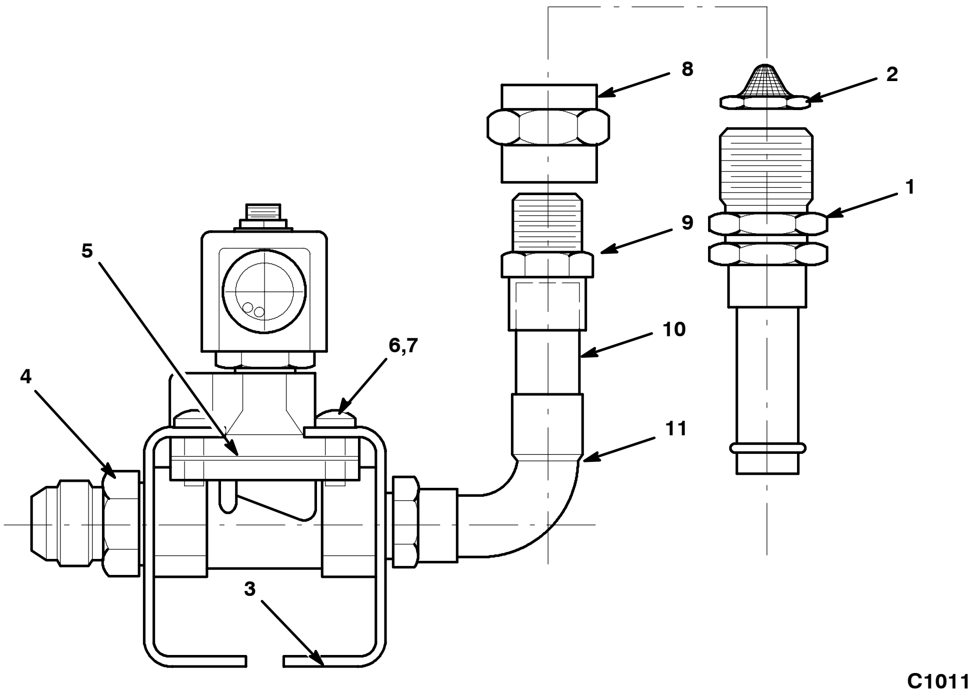

8
2
1
9
5
10
6,7
4
11
3
C1011

Figure 11. Driver's Heater Water Valve

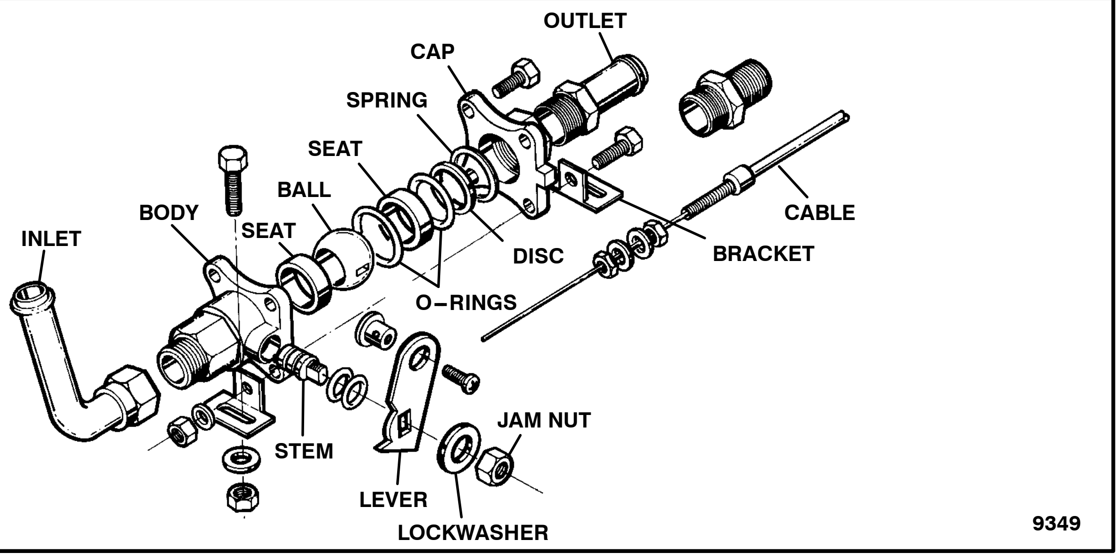

OUTLET
CAP
SPRING
SEAT
BALL
BODY
SEAT
INLET
CABLE
DISC
BRACKET
O–RINGS
JAM NUT
STEM
LEVER
LOCKWASHER
9349

Figure 12. Driver's Hot-Water Stop Valve

2. Unfasten fitting and remove screen. Backflush screen to remove any debris which may have been caught.

NOTE: Filter screens were installed on units 48187 through 49209.

REPLACEMENT

1. Turn main battery disconnect switch to "Off".
2. Open and secure the tire compartment door.
3. Disconnect solenoid wiring harness.
4. Unfasten the clamps securing the inlet and outlet hoses to the valve, and slide away from valve.
5. Unfasten and remove the valve from its mounting and remove.
6. Mount the new valve and reattach bracket, hoses and harness in reverse order.

Secondary (Driver's) Valve (Manual)

Some coaches may have the optional cable operated driver's hot-water ball valve (Figure 12).

REPLACEMENT

1. Turn main battery disconnect switch to “Off”.
2. Open and secure the tire compartment door.
3. Remove cable assembly from valve’s lever.
4. Unfasten and remove the valve from mounting bracket.

REPAIR

1. Unfasten and remove valve body capscrews and remove mounting bracket.
2. Open valve body and remove stem. Repair and replace seals as required.
3. Assemble ball into valve body (stem side), positioning stem correctly and assemble the remainder of the valve.
4. Attach the mounting brackets and tighten valve body capscrews.

AIR FILTER ASSEMBLY (MAIN VALVE)

The main and bypass hot-water stop valve installations include air filter assembly upstream of the valve. The air filter is a serviceable item which has a replaceable element. This filter should be inspected and/or changed every 50,000 miles (80,450 Km).

Filter Maintenance

1. Unfasten and remove the element bowl and O-ring.
2. Replace element and reassemble filter.

TEMPERATURE CONTROLLER ASSEMBLY

The temperature control units are electrically connected to coach power, main passenger and driver’s hot-water stop valves, ambient and interior temperature sensing probes (installed in the coach’s passenger duct and driver’s area). There are no serviceable items inside the temperature controller. For information on the particular wiring and electrical connections of the temperature controller, refer to the “Heating and Air Conditioning” schematics in Section 7J.

CONTROLLER TROUBLESHOOTING

Symptom	Probable Cause
Digital display rolls (will not synchronize).	Red or white wire from probe broken or loose.
Digital display gives reads in range of −85° to −95°F (−65° to −70.5°C).	Either of the red or white type “J” wires is grounded.
Digital display continues to increase, coach temp. gets colder.	Connections of red and white wires are reversed.

Replacement

1. Turn main battery disconnect switch to “Off”.
2. Unfasten instrument panel and tilt forward to gain access to back of controller.
3. Unfasten and remove the mount bracket from controller.
4. Disconnect wiring harness and slide controller out the front of the panel.
5. Mount the new controller and reattach the harness and bracket in reverse order.

HEATED STEPWELL

Heated air from a rear vertical duct attached to the RH sidewall duct is supplied to the stepwell area through vents in the front passenger’s modesty panel (Figure 13).

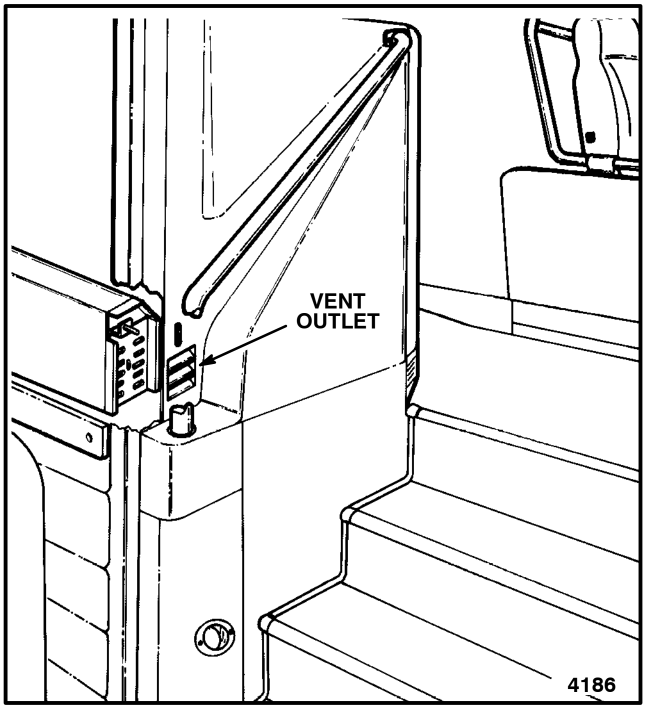


Figure 13. Heated Stepwell

DRAINING/FILLING HEATING SYSTEM

If the heating system is to be drained without draining the engine cooling system, close the isolation valves in engine compartment and drain both heater coils. A manual vent plug is provided in the top of the main heater core and at the top of the driver’s heater core for bleeding air while refilling. The vent plug allows air to enter during draining. Refer to Subsection 6C “Cooling System” for more detailed instructions on draining and refilling the heating system.

SECTION 16B

AIR CONDITIONING & VENTILATION

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	16B-1
Components	16B-3
Operation	16B-8
Maintenance	16B-11
Troubleshooting	16B-26
Specifications	16B-29

GENERAL DESCRIPTION

The 102D series coach models utilize a fresh air induction constant recirculating, refrigerant filled air conditioning and ventilation system design (Figure 1). The system provides the coach with a comfortable interior environment, regardless of the outside temperature.

The A/C system is designed to provide a nominal 13 tons of refrigeration capacity, or 156,000 BTU/hr of heat removal. The break-down is as follows: 10 tons main A/C system, 1 ton of secondary (driver's) A/C, and an additional 1 ton each for the secondary parcel rack A/C modules basic on the 102DL3 models.

The air conditioning system is designed to automatically operate at full rated capacity once it is activated, with adjustable main, secondary and parcel rack blower speeds. Heating system components are used to modify the A/C system's output temperatures during operation.

A mixture of cooled, dehumidified fresh and recirculated air is supplied through sidewall and floor distribution ducts. The mixture of fresh and recirculated air is continually filtered, resulting in a clean fresh atmosphere.

NOTE: Most coach air-conditioning systems will be filled with R-22 refrigerant, while others may use the optional R-134A environmentally safe refrigerant. Systems which contain the R-134A refrigerant can be distinguished by a green colored compressor and special service taps.

⚠ WARNING ⚠

Some coach air conditioning systems may contain HCFC-22, a substance which harms public health and environment by destroying ozone in the upper atmosphere.

NOTE: As required by the EPA, A/C maintenance recycling equipment must be used to reclaim refrigerants. No refrigerant should be released to the atmosphere.

The ventilation system of the D series coaches utilizes strategically incorporated distribution and return ducts that are built directly into the coach body, and allow for complete circulation of the interior air supply (Figure 1).

The system can, as a standard feature, automatically mix up to 20 percent of fresh air with the existing recirculated interior coach air supply. More fresh air can be added to the interior air supply if needed.

Fresh air is obtained through the "Ram Air" plenum of the front cap, and routed to the main and/or secondary (driver's) A/C and heating systems. Excess air is vented from the coach through the entrance door's lower grill.

The system economically cools and freshens the coach interior, with special attention to the driver's area. Additionally, the ventilating feature can be assisted by the blower assemblies of the main or secondary systems in either the A/C or heating modes.

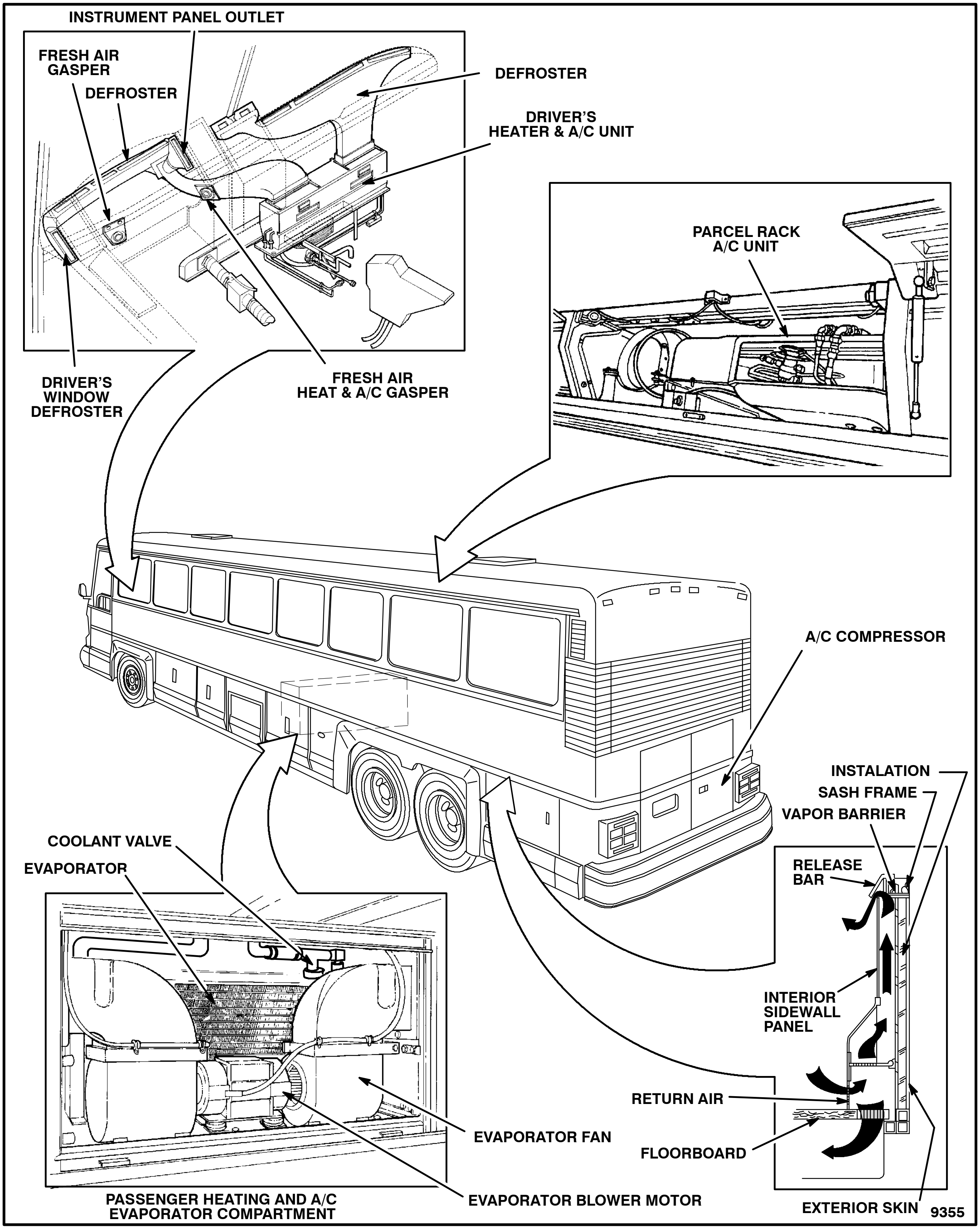

INSTRUMENT PANEL OUTLET
FRESH AIR GASPER
DEFROSTER
DEFROSTER
DRIVER'S HEATER & A/C UNIT
DRIVER'S WINDOW DEFROSTER
FRESH AIR HEAT & A/C GASPER
PARCEL RACK A/C UNIT
A/C COMPRESSOR
INSTALATION
SASH FRAME
VAPOR BARRIER
RELEASE BAR
INTERIOR SIDEWALL PANEL
RETURN AIR
FLOORBOARD
EXTERIOR SKIN
COOLANT VALVE
EVAPORATOR
EVAPORATOR FAN
EVAPORATOR BLOWER MOTOR
PASSENGER HEATING AND A/C EVAPORATOR COMPARTMENT
9355

Figure 1. Air Conditioning Ventilation System Components

COMPONENTS

AIR CONDITIONING SYSTEM

The air conditioning system's major components are: the A/C compressor, main evaporator coil assembly, condenser coil assembly, main HVAC blower assembly, condenser fan assemblies, receiver tank, main expansion valve, main liquid line solenoid valve, main hot-water stop valve, temperature controller, the secondary (driver's) heating/air conditioning/defroster module and the secondary (LH/RH parcel rack) air conditioning/blower module.

The components of the main (passenger) HVAC system are located either in the condenser compartment (condenser coil, condenser fan, receiver tank, main expansion valve and main liquid line solenoid valve), the main HVAC module (main evaporator coil, main HVAC blower and main hot-water stop valve), the engine compartment (A/C compressor), or the instrument panel (temperature controller).

The components of the secondary (driver's) HVAC system include the evaporator coil with expansion valve and dual blower assemblies in one module. The liquid line solenoid valve for the driver's module is remote mounted in the tire compartment. The secondary (driver's) module is located under the right-hand dash assembly. This secondary HVAC system is also utilized for defrosting both the windshield and driver's window.

The components of the secondary (parcel rack) HVAC system include the evaporator coil with expansion valve and thermostatically controlled blower assemblies in RH/LH modules. The liquid line solenoid valves for the parcel rack modules are remote mounted in the condenser compartment. The secondary (parcel rack) modules are located in the LH/RH parcel rack assemblies.

A/C Compressor Assembly

The A/C compressor is located in the RH corner of the engine compartment. It is a six-pistoned, reciprocating, positive displacement, heavy-duty reed valve refrigerant compressor. The compressor is belt-driven from the engine with adjustable tensioning device. Refer to sub-section 16C for detailed information on the compressor.

NOTE: The A/C compressor's operation is not thermostatically controlled.

Evaporator Coil Assembly

The evaporator coils are assembled adjacent to and as an assembly with the heating coils in both the main and secondary (driver's) systems (Figure 2). The evaporator coils for the secondary (parcel rack) systems do not have heating coils. The evaporator coil assemblies are copper tube with aluminium fins.

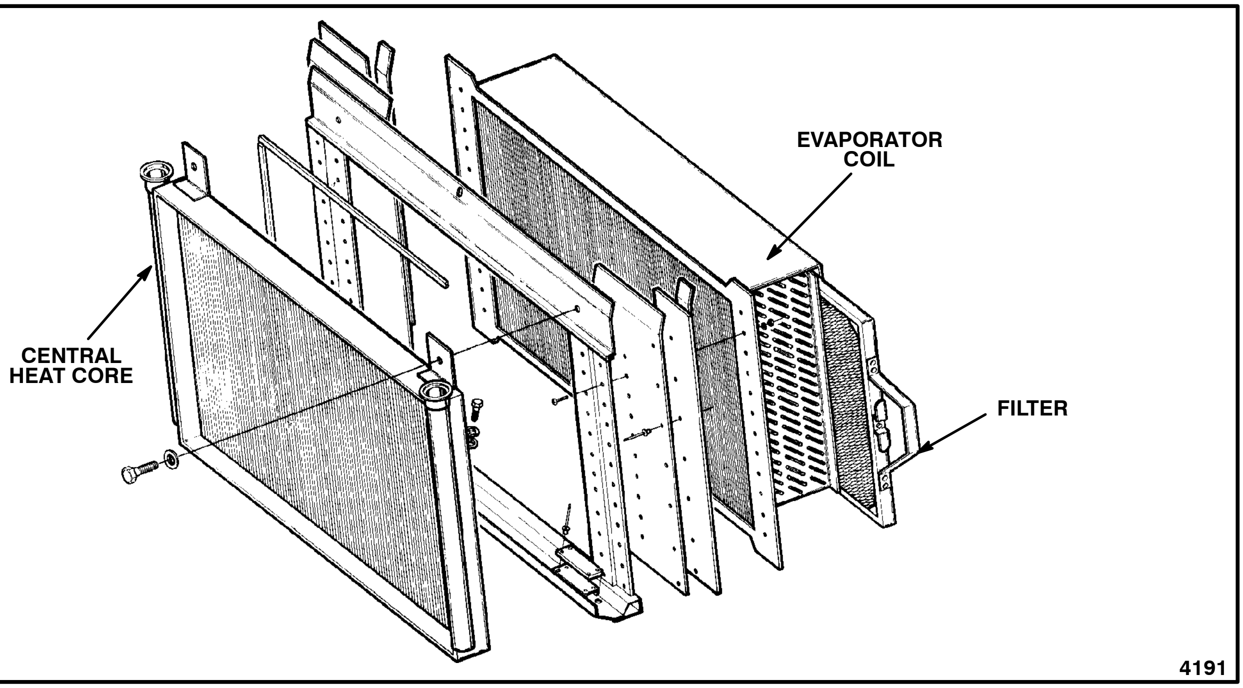


Figure 2. Main Evaporator and Heater Core

Condenser Coil Assembly

The condenser coil assembly receives and condenses the heated and compressed refrigerant gas, and routes it via the hose connector block to the receiver tank and/or evaporator. The condenser coil assembly is copper tube with aluminium fins (Figure 3). An optional all aluminium coil is also available.

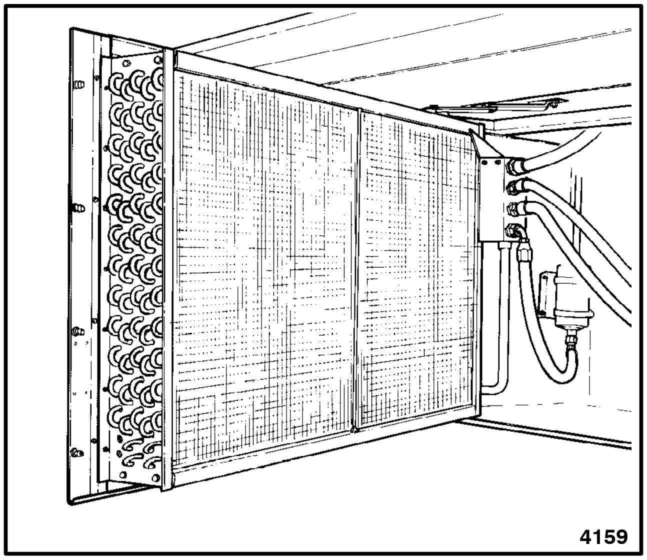


Figure 3. Condenser Coil Assembly

Main (Passenger's) Blower

The main HVAC two-speed blower assembly is a twin centrifugal type design, mounting a two-speed 24-volt twin-shaft 1-1/2 hp (1.1 kw) motor (Figure 4). The blower assembly is located inside the main evaporator compartment. The main blower's operation is automatically triggered when "A/C" switch is actuated. Main blower's speed is controlled by the "Main Blower Speed" switch on the upper left-hand switch panel.

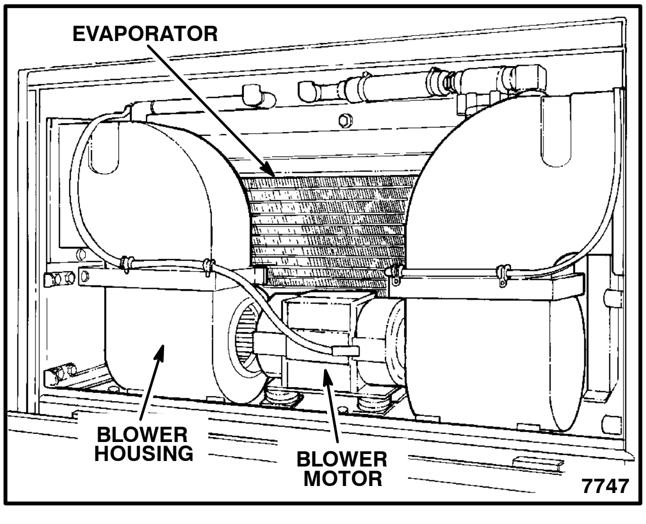


Figure 4. Main Blower Assembly

Secondary (Driver's) Blowers

The dual three-speed blowers of the secondary system are of the centrifugal type design, and assembled inside the driver's module. Their operation is manually controlled by the four-position defroster switch.

Secondary (Parcel Rack) Blowers

The dual-speed blowers of the secondary (parcel rack) systems are of the centrifugal type design, and assembled inside the parcel rack A/C modules (Figure 5). Their operation is manually controlled by the "Parcel Rack A/C" switch in conjunction with the "Parcel Rack Blower Speed" switch. Additionally, the blower assemblies of this system are also utilized for passenger ventilation functions.

NOTE: Parcel rack module's manually adjusted thermostatic control must be preset for operation.

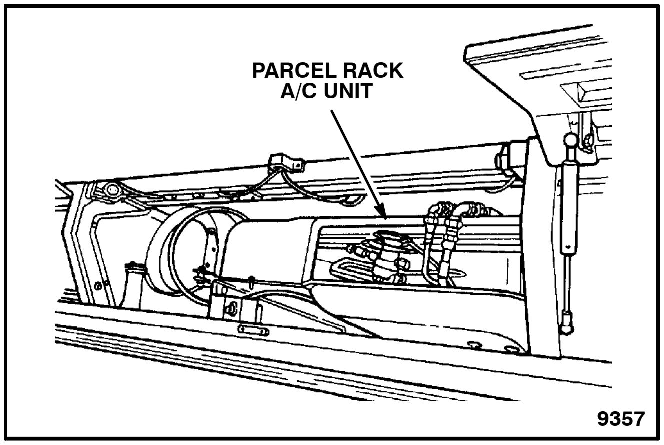


Figure 5. Parcel Rack HVAC Module

Temperature Controllers

The coach's main and driver's digital-function temperature controller are used to regulate A/C output by operation of the main and driver hot-water stop valves. The main controller has a digital readout feature showing the A/C output temperature in the coach passenger area. The rotary set point selector knob may be used to modify this output. Refer to section 16A of this manual for more information on the main and driver's thermostatic heat controllers, hot water stop valves and sensor probes.

NOTE: The unit is calibrated in either degrees Fahrenheit or degrees Celsius. It controls the coach temperature within 3°F (1.72°C). Temperature selection range is 65–85°F (18°-29°C). Each click of the rotary switch is equal to 2°F. The reference mark on the controller face is equal to 72°F.

Hot-Water Valves

The main hot-water stop valve is located inside the main evaporator compartment. The normally-open valve is electrically-controlled by solenoid valve and air-actuated. In the A/C mode the valve operates in the same manner as in heating.

The secondary (driver's) manually operated or solenoid actuated hot-water valve is located in the tire compartment and used in the A/C mode to modulate driver area temperatures. The manually operated hot-water stop valve is a cable-actuated ball valve and controlled from the "T" handle at LH side of driver. The solenoid operated valve is controlled by the driver's temperature control.

NOTE: The solenoid operated valve became basic effective with unit 47071.

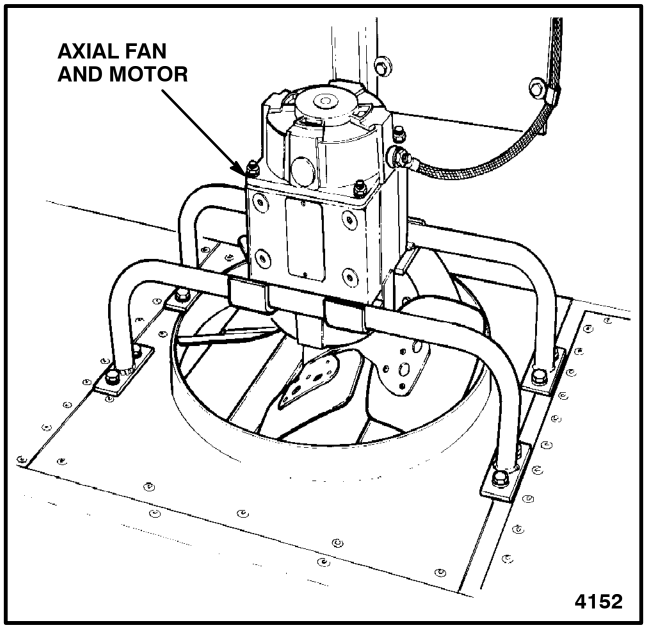


Figure 6. A/C Condenser Assembly

Condenser Fan Assembly

Twin single-speed single-shaft condenser fan motors are mounted to the floor of the condenser compartment (Figure 6). The fans draw air into the compartment through the condenser assembly, and exhaust out the bottom. These motors are wired in series/parallel with Hi/Lo speed controlled by a receiver tank mounted pressure switch and condenser fan motor relay.

NOTE: Effective with unit 49369 a corrosion resistant motor assembly became basic.

A/C Solenoid Valve - Main (Passenger's)

The main solenoid-operated normally-closed liquid line stop valve is located in the condenser compartment (Figure 7). The valve opens and closes the liquid line to the evaporator assembly. This valve must be open before air conditioning will operate in the secondary systems. The valve is opened by positioning the "Heat/AC" switch to "A/C", and closed when switch is in "Off" or "Heat" positions.

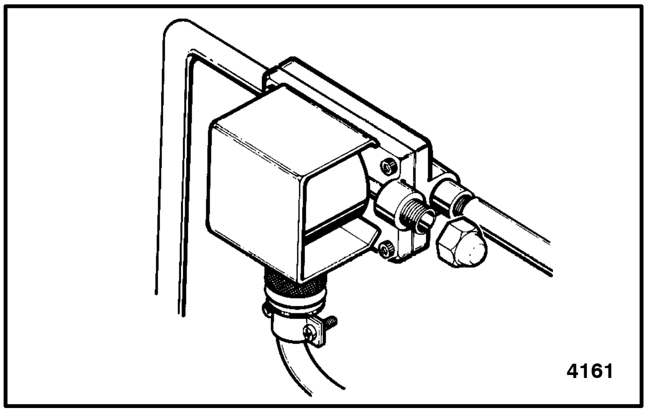


Figure 7. Main Liquid Line Solenoid Valve

A/C Solenoid Valve - Secondary (Driver's)

The secondary (driver's) solenoid-operated normally-open liquid line stop valve is located in the tire compartment (Figure 8). The valve opens and closes the liquid line to the evaporator assembly. The main A/C system's valve must be open before air conditioning will operate in the secondary (driver's) system. The valve is opened by positioning the "Driver AC" switch to "On", and closed when switch is in "Off" position.

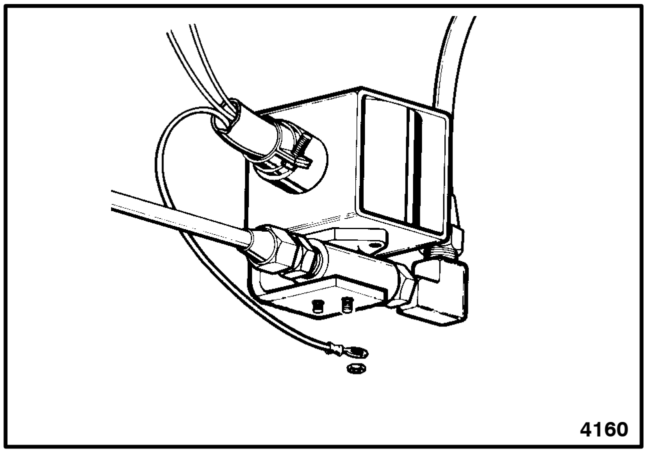


Figure 8. Driver's Liquid Line Solenoid Valve

A/C Solenoid Valve - Secondary (Parcel Rack)

The secondary (LH/RH parcel rack) solenoid-operated normally-closed liquid line stop valves are located in the condenser compartment. The valves open and close the liquid line to the evaporator assembly. The main A/C system's valve must be open, and the parcel rack module's thermostatic controller set before air conditioning will operate in the secondary (LH/RH parcel rack) systems.

The valve is energized by the positioning of the “Parcel Rack AC” switch to “On”. The valve opens (i.e., goes-to-ground) when the thermostat reaches high-end setpoint, and closes (i.e., breaks-ground) when thermostat reaches low-end setpoint, or when switch is positioned to “Off”.

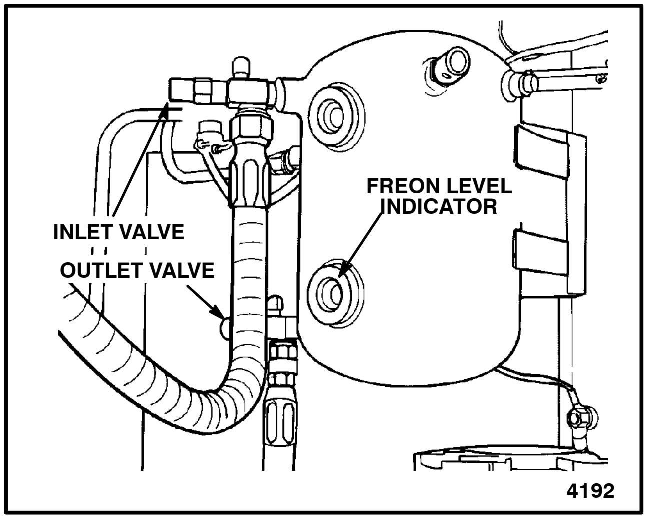


Figure 9. Receiver Tank

Receiver Tank Assembly

The A/C system’s receiver tank is mounted in the condenser compartment. The tank maintains the liquid refrigerant reservoir (Figure 9). The receiver tank incorporates an inlet and outlet valve so it can be isolated from the rest of the system for service. Two liquid level sight glasses can be observed by opening the LH #3 baggage bay door. The tank incorporates a pressure sensing condenser fan motor speed switch, and a pressure relief valve that will open at 550±10 psi (3792±69 kPa), and relieve pressure.

Filter/Dryer Assembly

The filter/dryer is installed between the receiver tank and expansion valve (Figure 10). is used to absorb moisture and trap particles in the liquid refrigerant flow.

Expansion Valve Assembly

The thermal expansion valve (TXV) allows liquid refrigerant to flow through it under falling downstream pressures. Increasing volume and pressure on the downstream side causes the valve to close. This metering of liquid refrigerant insures that the proper amount of heat ladened refrigerant in gaseous form returns to the compressor. The valve’s internal cage assembly controls the refrigerant flow. Refer to the Maintenance segment of this section for a complete explanation of the expansion valve’s operation.

The expansion valve’s are rate for the amount of refrigerant required in a given evaporator coil. The main expansion valve is rated for 10 tons. The secondary (driver’s) valve is rated at 1 ton. The secondary (parcel rack) valves are rated at 1-1/2 tons.

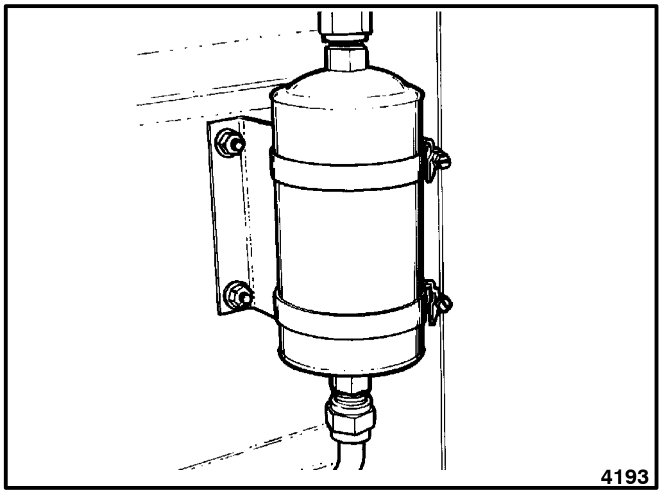
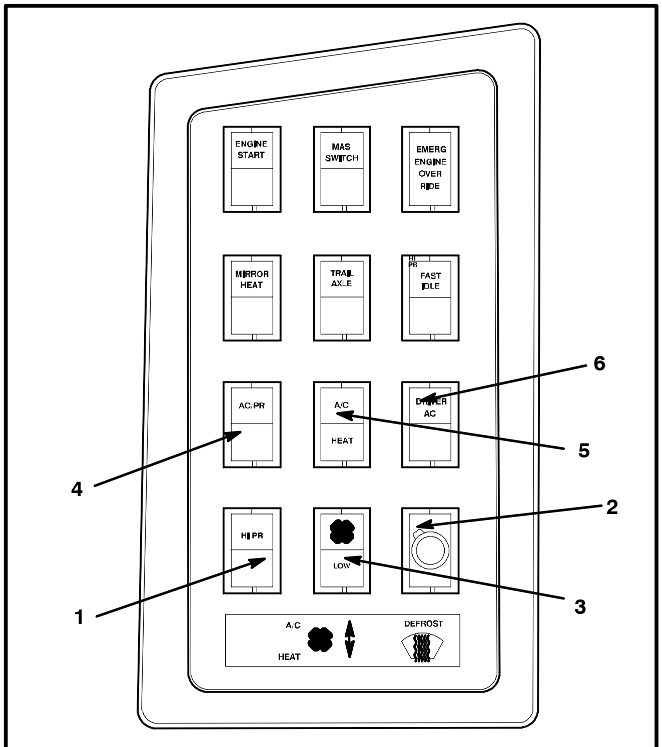


Figure 10. Filter/Dryer Assembly

A/C Switches

All of the air conditioning system’s control switches are located on the upper left-hand switch panel (Figure 11).



1. PARCEL RACK BLOWER SPEED HI/LOW
2. DRIVER’S HEATER/DEFROSTER BLOWER SPEED HI/LOW/MED
3. MAIN HVAC BLOWER SPEED HI/LOW
4. PARCEL RACK A/C
5. PASSENGER (MAIN) A/C
6. DRIVER’S A/C

Figure 11. A/C System Switches

Parcel Rack Module Blower Speed Switch

This two position switch controls the blower speeds of the parcel rack A/C modules.

Driver's Module Blower Speed Switch

This four position rotary switch (with "Off" position) controls the blower speeds of the driver's heater/defroster/A/C module. This switch is wired to provide blower function (low speed) any time the driver's A/C switch is positioned to "On".

Main Blower Speed Switch

This two position switch controls the blower speeds of the main HVAC blower assembly.

Parcel Rack A/C Switch

This two position switch enables both of the normally-open solenoid-operated liquid line stop valves of the parcel rack A/C system. The switch itself is enabled through the A/C "On" relay.

Main A/C Switch

This three position switch (with "Off" position) energizes the A/C "On" relay, the A/C compressor clutch coil, the normally-closed solenoid-operated liquid line stop valve of the main A/C system and enables the receiver tank over-pressure switch. The switch itself is enabled through the "Blower Discharge Cut-In" relay.

Driver's A/C Switch

This two position switch energizes the normally-open solenoid-operated liquid line stop valves of the driver's A/C system. The switch itself is enabled through the "Blower Discharge Cut-In" relay.

VENTILATING SYSTEM

The ventilation system includes structural items such as: the LH/RH central return ducts, the central heat frame, the sidewall-to-floor ducts (includes the sidewall void allowing a flow of air from just under the sash) and the transfer ducts for distribution and return air.

Additionally, the system includes components like the main (passenger's) ram air installation (Figure 12), the secondary (driver's) ram air installation, the the ram air plenum (i.e. part of the front fiberglass cap), the main HVAC filter assembly and the blower assemblies of the main and secondary heating/air conditioning/defrosting systems.

Main (Passenger's) Ram Air System

The main ram air system utilizes a butterfly valve assembly to control the amount of air that enters the main HVAC system. The main ram air system can be used in place of the heating system's components to modulate the coach air conditioning.

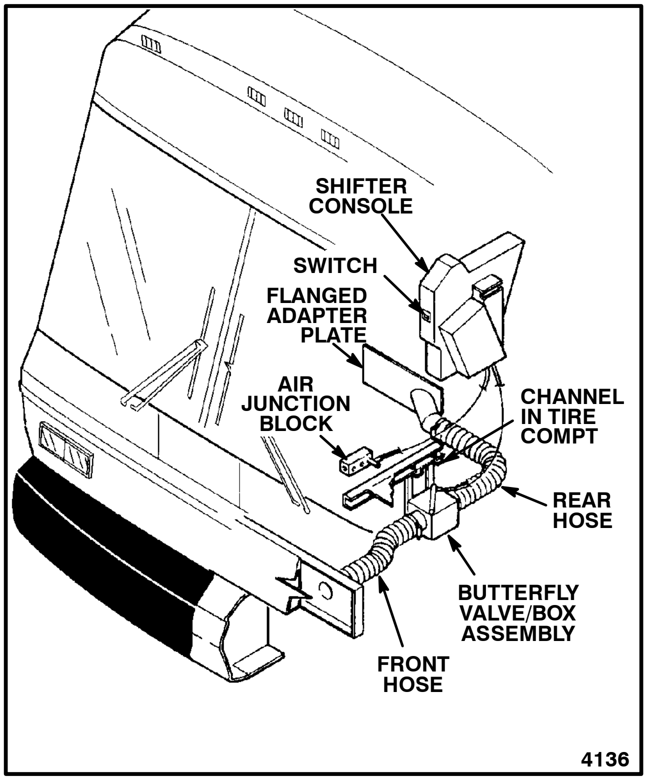


Figure 12. Main Ram Air

To achieve the required fresh air to recirculated air mixture, the valve incorporates a by-pass opening. This allows for a low-velocity constant fresh air flow. When more air is required the valve can be opened fully by the air-operated actuator switch mounted at the front of the driver's console.

The valve is located below the driver's area in the front side service compartment. The valve is connected by hose to the collector plenum's main LH ram air outlet and to the front of the LH return duct's inlet collar.

Secondary (Driver's) Ram Air System

The secondary (driver's) ram air system is an additional feature of the heater/defroster/air conditioning module in combination with the existing main ram air components. The air from this system is used to provide fresh air to the windshield and driver's instrument panel vents and seat gaspers. The air is routed from the module through integral LH/RH dashboard plenums and ducts

The secondary (driver's) ram air system can also be used in place of the module's heating system components to modulate the temperature of driver's air conditioning. In some instances heated ram air can be substituted for defroster's blower function.

The secondary (driver's) ram air system's damper when closed, shuts off all flow of fresh air completely. The module is connected by hose to the collector plenum's RH outlet.

Main (Passenger's) Blowers

The main (passenger's) HVAC blower assembly can be used to provide additional recirculating velocity to the ram air or existing air supply.

Secondary (Driver's) Blowers

The secondary (driver's) blowers can be used to provide additional velocity to the vents with the ram air or existing recirculated air supply.

Secondary (Parcel Rack) Blowers

The secondary (parcel rack) blowers can be used to provide additional velocity to the vents with the existing recirculated air supply.

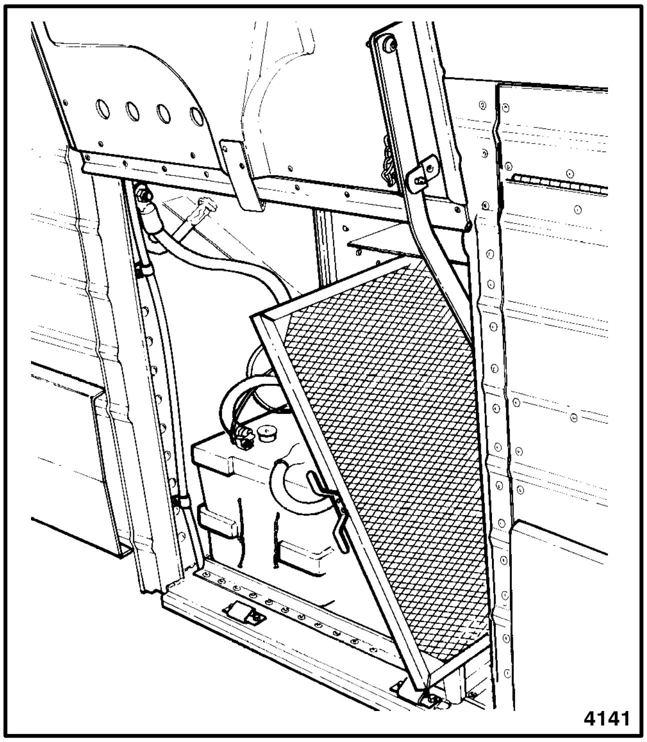


Figure 13. Air Filter

Main HVAC Filter Assembly

The entire air supply of the coach passes through a central filter assembly located in the main HVAC module's evaporator and heater compartment (Figure 13). The filter is removable, and can be reached through the battery compartment and filter doors. The secondary HVAC system(s) also have their own filter assemblies

NOTE: This filter could be a one-piece reusable metal element, or have replaceable filter media material. The new filter with disposable media cut-in with unit 47071.

OPERATION

AIR CONDITIONING SYSTEM

Heat-ladened refrigerant, in a gaseous form, is compressed by the A/C compressor, and flows through the discharge line into the condenser. The condenser cools the high-pressure gas, and it condenses into liquid form. It then enters the receiver tank where it cools further, before flowing through the refrigerant stop valve to the expansion valve.

As the high pressure liquid refrigerant enters the evaporator's lower atmosphere it expands in volume. As it expands it begins to absorb heat, via the transfer process, as it travels through the evaporator coil.

During this absorption of heat the refrigerant begins to boil, and turns back into a gas. While in this gaseous state the refrigerant is continuously absorbing heat as it nears the end of the evaporator coil. This is the stage at which superheat temperatures are attained. The gas then enters the suction line and returns to the compressor, where the process begins again. Refer to the location and function diagrams of the air-conditioning system (Figure 14 15).

NOTE: The cycle is basically the same whether it be the main A/C system or one of the secondary A/C systems.

Main (Passenger's) A/C

When air conditioning is required in the passenger compartment (main evaporator coil) the "Heat/AC" switch is positioned to "A/C". The switch is powered through the "Blower Discharge Cut-In" relay, and completes the circuit that energizes the main HVAC blower motor's relays inside the A/C junction box and on the blower motor control plate on the blower assembly, which starts the blowers.

Additionally, a circuit is completed that energizes the front junction box's A/C "On" relay which completes circuits to the compressor clutch, main liquid line solenoid valve, energizes the condenser fan motor relay and the parcel rack A/C relay.

For further information refer to the "Heating and Air Conditioning " schematic in sub-section 7J.

NOTE: The main (Passenger's) liquid line solenoid valve is normally-closed. A/C switch operation is interlocked with "Low Air Pressure" switch by way of the "Blower Discharge Cut-In" relay in the rear junction box.

Warm air is drawn from the coach interior through the center aisle return ducts by the HVAC's main blower. It is filtered, then cooled and dehumidified by the air conditioner's evaporator coil.

And, if needed, the air is then brought to the desired temperature by passing through the heating system's coil. The HVAC blower fans suck in the conditioned air and force it up and out into the distribution ducts.

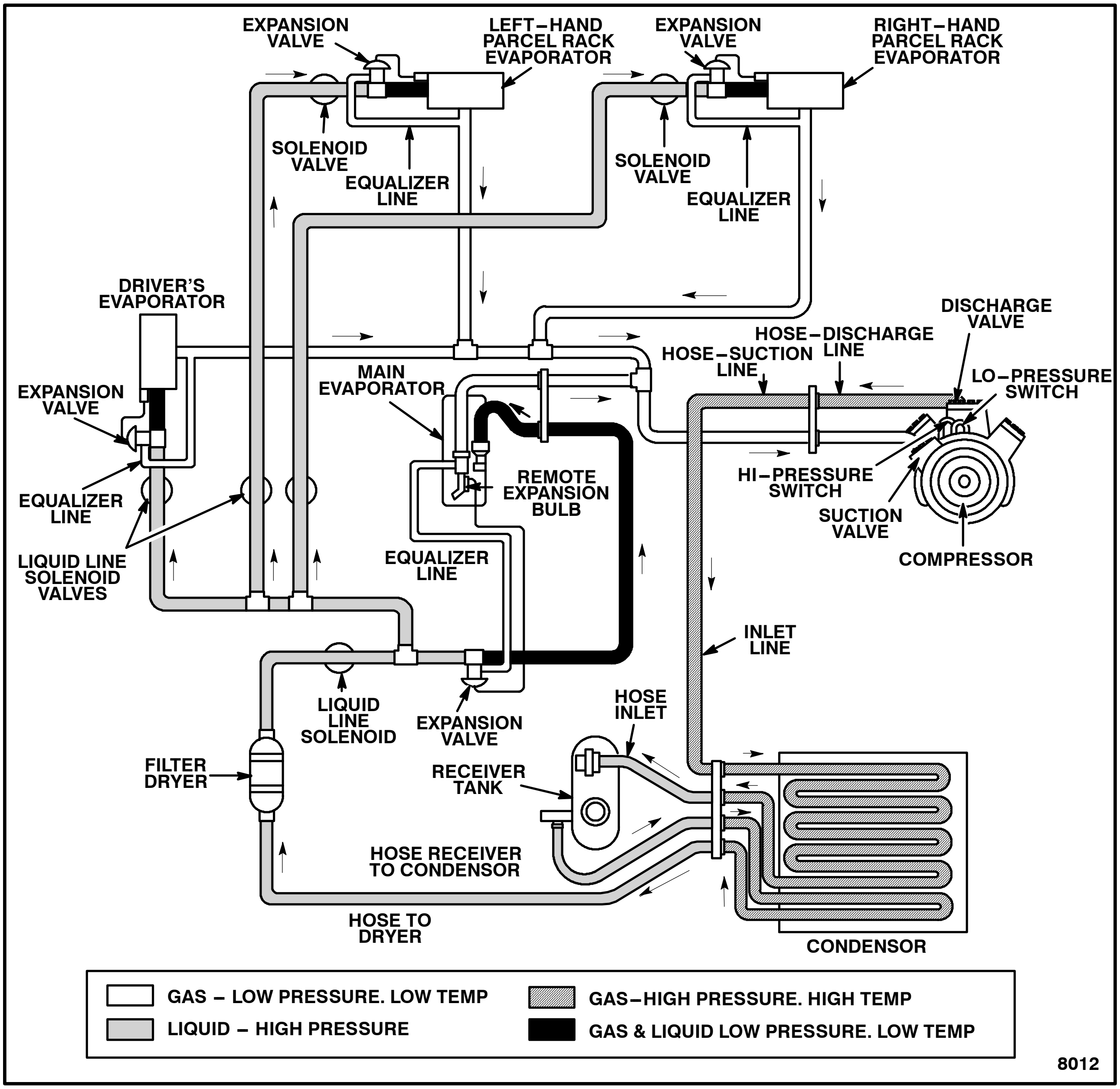

EXPANSION VALVE
LEFT–HAND PARCEL RACK EVAPORATOR
EXPANSION VALVE
RIGHT–HAND PARCEL RACK EVAPORATOR
SOLENOID VALVE
EQUALIZER LINE
SOLENOID VALVE
EQUALIZER LINE
DRIVER'S EVAPORATOR
DISCHARGE VALVE
HOSE–DISCHARGE LINE
HOSE–SUCTION LINE
MAIN EVAPORATOR
LO–PRESSURE SWITCH
EXPANSION VALVE
REMOTE EXPANSION BULB
HI–PRESSURE SWITCH
EQUALIZER LINE
SUCTION VALVE
LIQUID LINE SOLENOID VALVES
EQUALIZER LINE
COMPRESSOR
INLET LINE
LIQUID LINE SOLENOID
EXPANSION VALVE
HOSE INLET
FILTER DRYER
RECEIVER TANK
HOSE RECEIVER TO CONDENSOR
HOSE TO DRYER
CONDENSOR
☐ GAS – LOW PRESSURE. LOW TEMP
▨ GAS–HIGH PRESSURE. HIGH TEMP
▨ LIQUID – HIGH PRESSURE
■ GAS & LIQUID LOW PRESSURE. LOW TEMP
8012

Figure 14. Air Conditioning System Diagram

NOTE: As warm moist air passes over the cold evaporator coils, it condenses, creating condensate. This condensate drips off the coil and into the evaporator's drain pan and out through the pan's drain tubes.

Secondary (Driver's) A/C

When air conditioning is required in the driver's area, the "Driver's AC" switch is positioned to "On". The switch, which is also powered through the "Blower Discharge Cut-In" relay completes the circuit that energizes the secondary module's blower motors at low, or any previously set speed. This also de-energizes the normally-open secondary (driver's) liquid line solenoid valve and allows it to open.

NOTE: For further information refer to the "Heating and Air Conditioning " schematic in section 7J.

Secondary (Parcel/Rack) A/C

When air conditioning is required from the parcel rack air vents (module evaporator coil) the "Parcel Rack AC" switch is positioned to "On". This switch is powered through the front junction box's "Passenger's A/C On" relay via stud #57, and completes the circuit that energizes the "Parcel Rack Liquid Line Solenoid Valve's" relay. This opens the valves until their respective thermostats break-ground at set-point and close the valve.

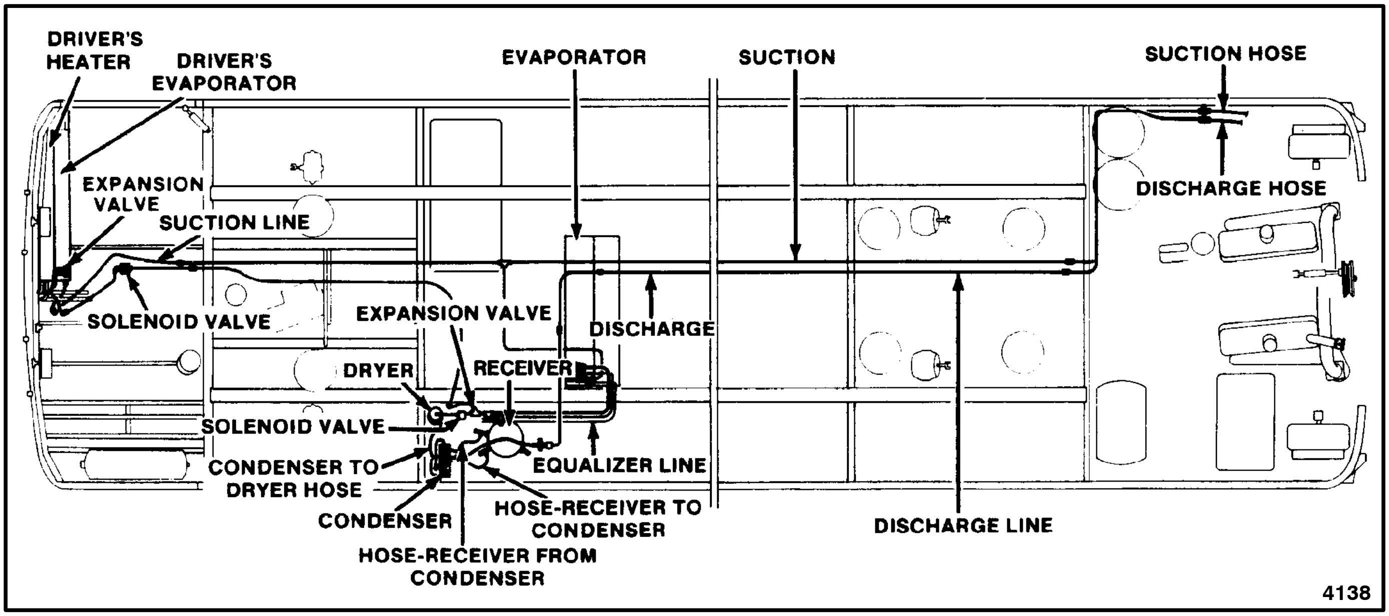


Figure 15. Principle A/C System Components

The solenoid valve's relay is powered through the "Passenger's A/C On" relay via A/C junction box stud #11. This switch also enables the "Parcel Rack Blower Motor" relays, which are energized via a 20 amp breaker on the front junction box's 24-volt buss bar and stud #95. This starts the secondary (parcel rack) module's blower motors at the speed switch's setting.

For further information refer to the "Parcel Rack Air Conditioning " schematic in sub-section 7J.

NOTE: The secondary (parcel rack) liquid line solenoid valve is normally-closed.

NOTE: The secondary A/C systems can not be operated, unless the main A/C system is already in operation.

Proper and economical operation of the air conditioning system depends on retaining as much of the conditioned air within the coach as possible. All windows and intake vents should be closed. An opening approximately eight inches square (203.2 mm) could easily neutralize the total capacity of the system.

Fast Idle Operation

It is recommended that when the coach makes an extended stop, that the fast idle switch be actuated. The engine's normal 750 RPM preset idle speed may not be sufficient to adequately cool the coach interior. The fast idle is activated by a switch on the driver's switch panel, and will bring engine idle up to approximately 950 RPM. The fast idle relay and resistor pack is located in the rear junction box. The fast idle feature cannot be activated unless the coach is stopped and the emergency parking brakes are applied.

Condenser Fan Assembly

The single-speed condenser fan motors are wired in series/parallel to a condenser fan motor relay. When temperature rises in the receiver tank, the pressure switch should energizes relay, which drops out series current operating motors in parallel for increase speeds of approximately 2200 RPM. When pressure in the receiver tank drops below 325 psi the pressure switch opens and condenser fan motor relay returns motors to series operation.

VENTILATION SYSTEM

Main (Passenger's) Ram Air System

The main ram air system utilizes a butterfly valve assembly to control the amount of air that enters the main HVAC system. The main ram air system can be used in place of the heating system's components to modulate the coach air conditiong.

When ram air is required the valve can be opened fully by the air-operated actuator switch mounted at the front of the driver's console. When activated the switch exhausts the air cylinder and allows the air to force open the butterfly valve.

Main (Passenger's) HVAC Blowers

The Main HVAC blower can be utilized solely for power recirculation of ram air or existing air supply. simply position the main "Heat/AC" switch to "Heat" and set temperature controller's upper set-point as high as possible. Set blower speed switch for comfort level desired.

Secondary (Driver's) Ram Air

A cable actuated hinged damper inside the driver's heater/defroster/air conditioning module controls the amount of ram air. The damper also controls the amount of ram air allowed to be mixed with recirculated air and distributed into the coach through the dashboard, windshield and gasper ducts and vents.

The driver's fresh air cable control is attached at the rear of the driver's foot rest cable mounting bracket. Unlock and push the cable down to open, pull up to close (Figure 16). Cable can be locked in either open or closed positions.

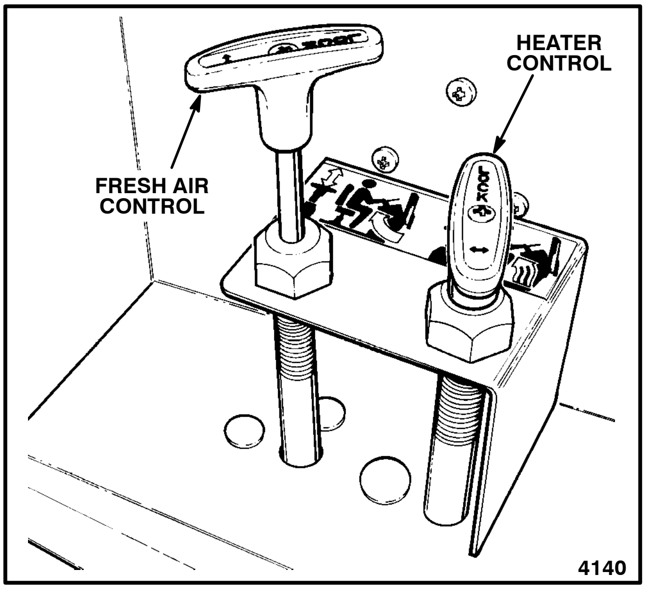


Figure 16. Air Cable Control

Secondary (Driver's) HVAC Blowers

The secondary HVAC blowers can be utilized solely for power recirculation of ram air or existing air supply. simply position the driver's "Defroster Blower Motor Speed" switch to the comfort level desired.

MAINTENANCE

One of the main causes of inadequate cooling is dirty air filters (main and secondary HVAC filters) or evaporator and condenser coil blockage. The HVAC system maintenance procedures that follow should should help in keeping the A/C system in good working order.

PERIODIC MAINTENANCE

The following procedures and/or inspections are grouped by the intervals in which they are required to be serviced or checked.

Interval: Check Daily

1. Check and clean air intake filter (main and secondary HVAC filters). (Use steam, water or solvent.) Re-install correctly for proper air flow direction.
2. Check compressor drive belt tension.

Interval: Check Weekly

1. Open and wash condenser coil. Use water or steam directed from compartment side of coil to back-flush.

⚠ CAUTION ⚠

Do not use caustic soaps. Use extra care to prevent bending fins.

2. Check refrigerant level in receiver.
3. Lubricate compressor clutch at 5000 miles (seasonal after 5000 miles).
4. Check compressor oil level.

⚠ CAUTION ⚠

Use only the correct lubricant, such as Texaco WF 68 WF1 132, or equivalent.

Interval: Seasonal

1. Check condenser and evaporator motor brushes.
2. Check condenser fan condition. Make sure blades are clean and undamaged to maintain balance.
3. Clean evaporator fan blades using steam or solvent. Make sure all blades are thoroughly cleaned to maintain fan wheel balance. Particularly, check cups of fan blades as accumulations of dirt are not always easily noticed.
4. Clean evaporator core. Remove access panel in main HVAC compartment and clean inlet side using a vacuum cleaner. Then backwash core from fan side using water or steam. Use extra care to prevent bending fins.
5. Examine air outlets below passenger windows for accumulated trash, refuse, etc..
6. Test system superheat. Adjust if necessary.
7. Check compressor operation.
8. Check system capacity.
9. Check Hi/Lo pressure switch operation.
10. Check filter dryer.
11. Lubricate compressor clutch.
12. Clean driver's hot water valve strainer.

BELT TENSIONERS

Manual Tensioning

A turnbuckle type mechanical tensioning device is provided to properly tension the compressor clutch drive belts. Tension belt by turning turnbuckle.

NOTE: The turnbuckle tensioner is basic effective with unit #47071.

Automatic Tensioning

An optional air-operated air conditioning compressor belt tension air cylinder can be installed to keep the correct tension of A/C compressor drive belts. Access to the air cylinder can be gained through rear engine compartment door (Figure 17).

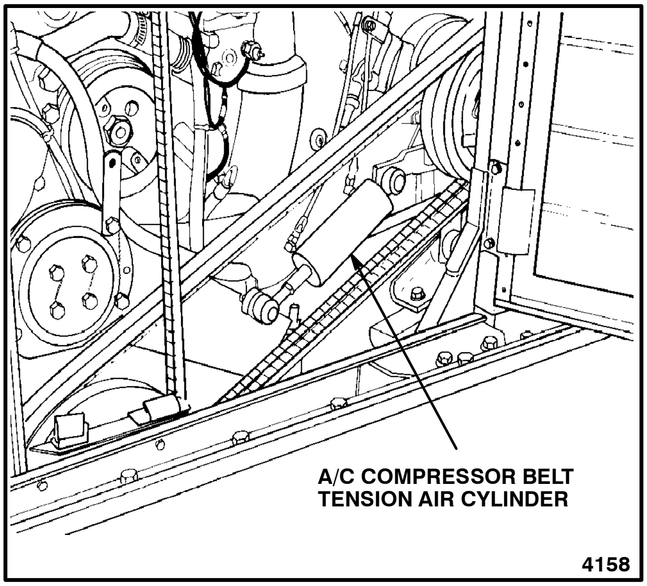


Figure 17. Belt Tension Cylinder

Tensioner Air Pressure (Regulator)

An air pressure regulating valve provides belt tension air pressure to the A/C compressor to prevent belt slippage. The required air pressure from the regulator is 95 psi (655 kPa). Perform this procedure to adjust the belt tension pressure regulator valve:

1. Install an air pressure gauge between the regulating valve and the belt tightener air cylinder.
2. Turn 2-way control valve to off and on positions several times and observe pressure reading on gauge.
3. If final pressure reading is not 95 psi (655 kPa), loosen locknut at top of regulating valve.
4. If pressure is higher than 95 psi (655 kPa), turn regulator adjusting screen counterclockwise and turn 2-way valve to off and on several times. When reading is less than 95, proceed to step 5.
5. While observing air pressure gauge, turn adjusting screw clockwise until the required 95 psi (655 kPa) reading is reached. Tighten the locknut.
6. Remove air pressure gauge and reconnect lines.

Tensioner Lubrication

The A/C compressor belt tensioning air cylinder should be lubricated at regular intervals, approximately every 30,000 miles (48,000 km). The recommended procedure is as follows:

1. Remove air feed hose from cylinder and apply a few drops of SAE 30 or 40 engine oil into cylinder hose connector.
2. Reconnect the hose, then reverse the air supply to the cylinder to lubricate the other end of the cylinder.
3. Check the cylinder for air leaks and recondition it as required.

NOTE: Do not attempt to disassemble air cylinder in coach.

Belt Tensioner Removal

1. Shut off air supply by turning control valve handle to compress the cylinder spring and relieve belt tension.
2. Remove drive belts.
3. Unfasten and remove locknuts and bolts securing cylinder's rod ends to mounting brackets, and remove from coach.

Belt Tensioner Dissassembly

1. Disconnect feed and exhaust hoses at the air cylinder.
2. Remove the uniball ends from air cylinder assembly.

⚠ **WARNING** ⚠

Air cylinder end plate is under 50-60 lbs. (22.6-27.2 kg) spring pressure. care must be exercised to avoid injury when disassembling the cylinder.

3. Using an arbor press, depress the piston rod into the cylinder approximately1/2 inch (12.7 mm) before attempting to remove retaining ring.

⚠ **CAUTION** ⚠

Avoid depressing piston rod beyond 1/2 inch (12.7 mm) as spring pressure increases with more compression. Take care not to damage any threaded surfaces.

4. Remove end plate retaining ring using a suitable pliers and screwdriver if necessary.

1. END PLATE
2. END BUSHING
3. PISTON
4. SHAFT
5. CYLINDER ASSY
6. SPRING
7. O–RING
8. O–RING
9. RETAINING RING
10. PACKING
11. FELT OILER
12. LINK END – COMPRESSOR
13. LINK END – ENGINE
14. OIL SEAL
15. O–RING
16. LOCK WASHER
17. NUT
18. JAMNUT

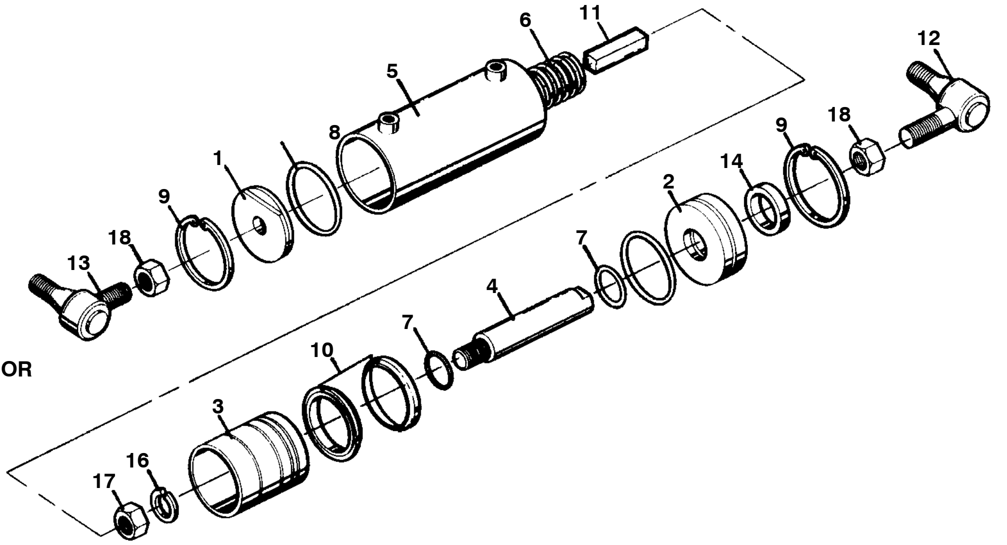


Figure 18. Belt Tension Cylinder Components

5. Slowly release pressure on piston rod and cylinder assembly thus allowing the end plate to come clear of cylinder.

6. Internal parts can now be removed for cleaning and inspection (Figure 18).

Inspection

Inspect all O-rings, cups, felts and seals; replace if damaged. Inspect cylinder bore and piston for scoring and replace if damaged. Refer to Specifications at end of this section for spring rate tension and replace if not within tolerances. Inspect retaining ring and replace if bent or damaged.

Belt Tensioner Reassembly

1. Coat all new parts with SAE 30 or 40 engine oil prior to assembly.

2. Reassemble the. cylinder in reverse order of disassembly.

3. Hold the cylinder in an upright position and install the spring and oil felt in position over the boss on the lower end plate. The same applies when piston assembly and end plate are installed.

4. Place in vise or arbor press. Apply pressure against piston rod. Be careful not to damage seal.

5. Compress end plate approximately 1/16 inch (1-5 mm) beyond retaining ring groove and install retaining ring.

⚠ CAUTION ⚠

Care must be taken at assembly not to allow piston rod or air cylinder to slip out of vise or arbor press.

Belt Tensioner Installation

1. Install A/C compressor air cylinder belts. Assemble locknuts and bolts securing rod ends to mounting bracket on engine cradle and bracket on compressor.

2. Connect feed and exhaust hoses.

3. Turn control valve handle to "ON" position.

4. Check the extension of the actuating shaft of the air cylinder. It should be 1¼±⅛ inch (31.7±3.1 mm) under recommended air pressure from the air pressure regulating valve (discussed below).

NOTE: Shaft extension should be as specified in step 4 regardless of the length of the belts.

5. If shaft extension requirement is not as specified, loosen shaft jamnuts and adjust to achieve the specified extension. Tighten the jamnuts.

Follow the above procedure when new belts are installed. After 500 miles (800 km), check the shaft extension dimension and readjust as necessary. Refer to "Tensioner Air Pressure" for air pressure adjustment.

MAJOR SERVICE (SYSTEM)

Adding Refrigerant

Always charge the system with the refrigerant cylinder upright and the valve on top to avoid drawing liquid out of the cylinder. When charging an empty system, weigh the amount of refrigerant put into the system. This will eliminate any possibility of overfilling. A full charge is exactly 26 pounds (10.9 kg).

1. Backseat the suction service valve on the compressor and loosely connect a charging line from the refrigerant cylinder to the valve.

2. Tighten the connection at the refrigerant cylinder and evacuate the hoses with the refrigerant recovery unit.

3. Screw the stem of the suction valve in approximately two turns.

4. Start the engine (compressor) and run at fast idle. Add sufficient refrigerant to bring the level in the receiver tank lower sight glass to mid-point.

Pumping Down

Whenever it is necessary to "open" the refrigeration system for service or repairs, the refrigerant must be removed from that part of the system requiring service. Localizing refrigerant into one part of the system (usually the receiver) is known as "pumping down." The procedure is as follows:

1. Close the outlet valve on the receiver, backseat the suction valve, install a gauge and turn the valve forward ¼ turn, thus enabling visual check of the suction pressure.

2. Connect a jumper wire between horizontal studs 1 and 2 in remote control box.

NOTE: This jumper will allow the compressor clutch to remain engaged after pressure drops below 15 psi (103.5 kPa).

3. Start the engine and operate the compressor until pressure reads 1-2 psi (6.9-13.8 kPa), then disconnect the jumper wire.

4. The pressure will probably rise. Install jumper wire again and lower the pressure until it remains at 1 or 2 psi (6.9-13.8 kPa). Close inlet valve to receiver tank. Stop compressor.

5. Close the discharge valve at the compressor.

6. Close the suction valve at the compressor.

⚠ CAUTION ⚠

During this operation, care must be taken not to fill the receiver tank over the top sight glass. Always allow refrigerant piping and system components to warm up to the ambient air temperature before opening system or sweating will take place inside the lines with resultant system contamination.

Evacuating System

NOTE: As required by the EPA, A/C maintenance recycling equipment must be used to reclaim refrigerants. No refrigerant should be released to the atmosphere.

1. Remove protective caps from the service gauge pressure tap ports on the suction and discharge valves.

2. Connect service gauges and backseat both the suction and discharge valves on the compressor.

3. Connect the line from the gauge manifold to the vacuum pump. Connection should be tight.

4. Midseat the valves at the high and low sides of the service gauge manifold.

5. Evacuate the system with the refrigerant recovery unit.

6. Midseat the suction and discharge service valves.

7. Start vacuum pump and run until vacuum in the system is from 29.5 to 29.7 in-Hg, then run 4-5 minutes longer.

NOTE: To check the system, proceed as follows:

8. Close valve between manifold and pump.

9. Shut off pump and wait 15 minutes. If the vacuum falls no more than 2 in-Hg during that time period, the system is dry and free of leaks. If the vacuum falls more than 2 in-Hg and stops, it indicates there is moisture remaining in the system and further evacuation is required. (Repeat steps 9-11.) If the vacuum falls more than 2 in-Hg and continues to fall, it indicates a leak in the system.

10. If there are no leaks or moisture in the system, close the suction and discharge service valves on the compressor.

NOTE: To remove gauges, proceed as follows:

11. Start engine and compressor.

12. Backseat compressor discharge service valve.

13. Backseat both high and low side hand valves of gauge manifold with discharge service valve backseated.

14. Backseat compressor suction valve.

15. Shut engine off.

16. Remove the hoses from the compressor.

NOTE: If hoses are attached to dummy fittings on back of manifold, there will be enough refrigerant left in the lines to give a slight positive reading to prevent dirt and moisture from entering the gauges.

Charging System

When a system has been opened or if there is any question about the air or moisture in the system, evacuate the system. Charging of an evacuated system may be accomplished by forcing liquid refrigerant directly into the receiver tank.

This may be accomplished by placing the refrigerant tank upside down on a scale (bathroom type) with the valves at the bottom and liquid charging. This ensures that only liquid enters the receiver tank.

1. Backseat the two compressor shut-off valves (out).
2. Install the gauge manifold set at the shut-off valves noting that the 600 psi (4136.4 kPa) gauge is connected to the discharge.
3. Turn in the two shut-off valves 3-4 turns.
4. Open the lower receiver valve by turning all the way out.
5. Backseat the upper receiver valve by turning all the way out.
6. Remove the cover cap from the service fitting in the top receiver valve.
7. Evacuate the hoses with the refrigerant recovery unit.
8. Connect the charging hose to the service fitting.
9. Open the refrigerant tank valve.
10. Turn in the upper receiver valve several turns. The refrigerant will now enter the system.
11. The proper charge of refrigerant is 26 pounds (10.9 kg).
12. When the scale indicates this amount of charge, backseat the receiver valve and close the refrigerant tank valve.
13. Disconnect the charging hose. Replace the cover caps.
14. The system is now ready for operation.

Air In System

The presence of air in the air conditioning system may be determined by the following test procedure. To check for air, the system must be off and cooled to ambient temperature:

1. Connect test gauges to A/C compressor and record suction pressure and discharge pressure (head pressure).
2. Compare the readings. If the difference between the two readings is greater than 5 psi (34.5 kPa), air is present and the system should be evacuated.
3. If the difference between suction and discharge pressure is within 5 psi, connect a gauge to the test fitting on the main expansion valve and record the pressure. Compare this reading with the suction pressure.
4. Check the pressure on the driver's expansion valve in the same manner. Compare the reading with the suction pressure.
5. If there is more than a 5 psi (34.5 kPa) difference between suction pressure and either expansion valve pressure, air is present and the system should be evacuated.

NOTE: Before soldering any part of the system, make sure the area is well ventilated. After completing repairs, vacuum test joints for leaks.

NOTE: When using heat at or near any valve or adjacent connections, wrap with a water saturated rag to prevent overheating of vital parts.

Lubrication

Too much oil in the system is as harmful as too little. To ensure proper lubrication, the level should be maintained within certain limits.

Sight gauges are located on both sides of compressor crankcase. Oil level is correct when engine side sight gauge is full and curb side sight gauge is empty.

After standing idle for any length of time, the compressor will normally pump crankcase oil into the system and approximately 20 minutes of running time may be required to bring it back to the crankcase.

After the unit has run at least one-half hour, the crankcase temperature should be warm to touch. If cool, this indicates the expansion valve adjustment is passing too much liquid or there is excessive oil in the system. Oil level is always lower in a cool crankcase due to cooling evaporating refrigerant causing oil to foam and be carried out into the system.

Purging System (Receiver Tank)

Abnormal high head pressure sometimes indicates non-condensible gases in the receiver tank. In order to purge such gases that might accumulate in the system, use the test gauge fitting on the intake valve to purge the receiver tank.

Refrigerant liquid should never be visible in upper sight glass and refrigerant should not be added unless the system has been operated as previously outlined.

Leak Testing

All lines are copper tubing or Aeroquip #1540 hose. The copper lines have soldered joints and the large hose connections have a rubber O-ring seal.

The most common method used is a halide torch consisting of an acetylene tank, a burner and a suction test hose. This no longer a recommended method of testing for leaks, because of the health hazard from the burning freon.

An electronic Halogen Leak Detector is recommended. A computer-like beeping sound increases in both speed and frequency as the leak is approached. It is more accurate and sensitive than the torch. Occasionally a soap solution may be necessary to pin-point the exact point of the leak.

Probe end of tester around all joints, valves, etc. When a leak has been found at a soldered joint, that section of the system must be pumped down. Do not solder if pressure exists in the joint as pressure will force melted solder away from joint.

If the system is empty, it is more economical to put in just enough refrigerant to produce about 15 psi (103 kPa). The pressure can then be raised to about 150 psi (1035 kPa) with dry nitrogen.

NOTE: This gas is put into the system through the suction or discharge service valves. The receiver tank's valves must also be opened. If no leaks are found dump this mixture, and evacuate the system. Recharge the system with new refrigerant.

CONDENSER

Condenser Coil

The condenser assembly is designed to cover the condenser compartment like a door. The condenser coil is mounted on the inner side of the compartment door. Dirt or other foreign matter clogging the coil may cause high head pressure and/or reduced system efficiency. It is important to keep the condenser coil clean.

Flush the condenser coil from inside out, using a water jet or water mixed with air pressure regularly. Direct the pressure straight through the coil to prevent bending of fins. For extremely dirty coils use Kelite 28 as a cleansing agent. Mix with cold water and wash the coil. Rinse with cold water.

⚠ CAUTION ⚠

Do not use a high pressure water jet, steam or harsh soaps.

The condenser compartment also houses the condenser fans and motors, receiver tank, expansion and solenoid control valves.

Condenser Fan Motor Assembly

The condenser fan and motor assemblies are mounted on the compartment's floor, and pull raw unfiltered air through the condenser coil to cool it. A periodic cleaning and inspection of the condenser fan and motor assemblies should be done every 5,000 operating hours (more often in dusty environments). Cleaning should be done by high-pressure air.

Lubrication is not necessary since the motor is a sealed, self-lubricated unit. However, the brushes should not be allowed to wear shorter than 3/4 inch (19 mm).

Testing Condenser Motor

To test the current draw of the 24-volt 2 hp motors proceed as follows:

1. Connect an ammeter in series with the motor lead. The ammeter hook-up must allow the condenser door to be fully closed during the check.
2. Start the engine and set at fast idle.
3. Place the A/C-Heat Switch in the A/C position.
4. Observe the ammeter reading. Current draw on motors should be 89.2±4 amps at 27.2 VDC at high speed (2320 rpm) and 26.8±4 amps at 27.2 VDC low speed (1260 rpm).
5. If the motor draws excessive current or runs slow, check the system further to determine the cause (air flow, brushes, relay, pressure switch etc.).

Brush Installation

1. Turn battery switch to "Off".
2. Open and secure the condenser door assembly.
3. Unfasten and remove the inspection covers from the rear end shield.
4. Unfasten and remove the brush assembly's "pigtail" screw, and remove brush and spring loaded housing.
5. Unfasten contact wire and remove brush assembly. Install new brush assembly and reverse procedure.

Replacement

1. Turn battery switch to "Off".
2. Open and secure the condenser door assembly.
3. Disconnect the condenser motor harness.
4. Unfasten the condenser motor mounting brackets from compartment floor and remove the assembly.
5. Disassembling the old motor and guard from mount brackets.

Note: A wheel puller may be required to remove fan blade from shaft.

6. Reassemble the motor onto the brackets and install into condenser compartment floor.
7. Install the fan blade onto motor shaft noting the orientation, and then turn the fan to check for proper clearance between the blades and floor shroud.

Note: A 1/4 inch minimum clearance is required between blades and floor shroud.

8. After proper clearance has been attained, tighten the motor thru bolts and mounting bracket fasteners securely.
9. Position the fan blade so that the hub end is flush with the motor shaft end and tighten the fan hub set screws.

10. Reinstall the fan guard and reconnect the electrical harness.

11. Turn the main battery switch to "ON" and check operation of condenser fan motors.

NOTE: When replacing old condenser motor with the newer corrosion resistant motor, some minor modifications may be required to enlarge the slotted hole on each motor mounting tab of bracket.

EVAPORATOR

Evaporator Coil

The evaporator assembly is located in the main HVAC Module's heating and cooling compartment. The evaporator in assembly with the heating coil is mounted across the main blower assembly's inlet opening.

Dirt or other foreign matter clogging the coil may cause a restriction in air flow through the evaporator and/or reduced system efficiency. It is important to keep the evaporator coil clean. The evaporator should be cleaned with a cleansing agent not harmful to aluminum or copper.

The evaporator can be checked and cleaned by removing the blower access door at the rear of the compartment. Also keep the compartment seals in weathertight condition to assure proper coach air circulation.

NOTE: Be sure that the drain pan drain tubes are clear and not plugged before cleaning evaporator coil.

Evaporator Blower Assembly

The evaporator blower assembly is mounted to the floor of the heating and cooling compartment below the evaporator/heater coil assembly. Filtered air is drawn through the coil. A periodic cleaning and inspection of the evaporator blower's fan and motor assemblies should be done every 5,000 operating hours (more often in dusty environments). Cleaning should be done by high-pressure air

Lubrication is not necessary since the motor is a sealed, self-lubricated unit. However, the brushes should not be allowed to wear shorter than 3/4 inch (19 mm).

Testing Evaporator Motor

To test the current draw of the 24-volt 1-1/2 hp motor proceed as follows.

1. Connect an ammeter in series with the motor lead. The ammeter hook-up must allow the evaporator compartment door to be fully closed during the check.
2. Start the engine and set at fast idle.
3. Place the A/C-Heat Switch in the A/C position.
4. Observe the ammeter reading. Current draw on two speed motors should be 68±4 amps at 27.2 VDC high speed (2250 rpm) and 36.8±4 amps at 27.2 VDC low speed (2125 rpm).
5. If the motor draws excessive current or runs slow, check the system to determine the cause (motor bearings, brushes,air flow, etc.).

CAUTION

Do not use emery cloth or sandpaper for seating brushes or cleaning commutators. Seat new brushes with a bedding stone.

NOTE: Blowers and tapered lock bushings are dynamically balanced. Before removing the bushing, match-mark the fan and bushing to allow re-installation in the same position.

Brush Installation

1. Turn battery switch to "Off".
2. Open and secure the main HVAC blower door panel.
3. Unfasten and remove the inspection covers from the front end shield.
4. Unfasten and remove the brush assembly's "pigtail" screw, and remove brush and spring loaded housing.
5. Unfasten contact wire and remove brush assembly. Install new brush assembly and reverse procedure.

RECEIVER TANK

The function of the receiver tank is to store the liquid refrigerant. During normal operation the level of the refrigerant should be approximately at the half-way mark on the lower sight glass.

The system requires approximately 26-28 lbs. (10.9 12.2 kg) of refrigerant R-22. The liquid should be approximately half-way on the lower sight glass after 30 minutes of engine operation in fast idle with coach interior at approximately 70°F (21°C). Refrigerant liquid should never be visible in upper sight glass and refrigerant should not be added unless the system has been operated as previously outlined.

FILTER/DRYER

A plugged filter/dryer is indicated by differences in temperature on either side of it. When plugged the filter/dryer must be replaced.

1. Isolate the refrigerant between the liquid line solenoid valve(s) and the receiver tank. If equipped with filter dryer isolation valves, use those.
2. Install a service gauge and evacuate the condenser and filter/dryer lines at the tank outlet.

3. Change the filter/dryer element.

4. Admit a small quantity of refrigerant gas to the filter/dryer, and check for leaks. Return the system to normal operation.

SOLENOID VALVES

Main (Passenger's) A/C Solenoid Valve

When the main (passenger's) normally-closed A/C solenoid valve is actuated it opens and allows refrigerant to flow to the main system's expansion valve and both of the secondary system's A/C solenoid valves. Turning the switch off will close the valve. This valve is located in the condenser compartment.

The valve can be operated manually if a malfunction in the electrical circuit between the valve and driver's switch or relay occurs. To manually open the valve follow this procedure:

1. Remove seal cap from the top of the valve's solenoid operator.

2. Using a wrench on the exposed 3/16 inch square stem, turn it counterclockwise 180 degrees (1/2 turn).

⚠ CAUTION ⚠

Turn only 180 degrees counter-clockwise. Do not backseat the valve.

To manually close the valve return the stem 1/2 turn clockwise until it is tight (seated).

Secondary (Driver's) A/C Solenoid Valve

When the secondary (driver's) normally-open A/C solenoid valve is actuated, (by cutting the circuit), it opens and allows refrigerant to flow to the secondary system's expansion valve. Turning the "Driver's A/C" switch off will close the valve. This valve is located in the tire compartment.

Secondary (Parcel Rack) A/C Solenoid Valve

When the secondary (parcel rack) normally-closed A/C solenoid valves are actuated they open and allow refrigerant to flow to the secondary system's expansion valves, until the thermostat breaks ground and closes them. Turning the "Parcel Rack A/C" switch off will close the valves, also. These valves are located in the condenser compartment.

NOTE: After manually operating the valve, the stem must be returned to the closed position before automatic operation by the solenoid valve will occur.

Whenever the A/C system is being serviced, or when an A/C system problem is being investigated, these valves should be inspected to determine if they are operating correctly. If the valves are not functioning properly, check the electrical connections and check for damage to the wiring. Refer to the "Heating and Air Conditioning" schematic in sub-section 7J of this manual.

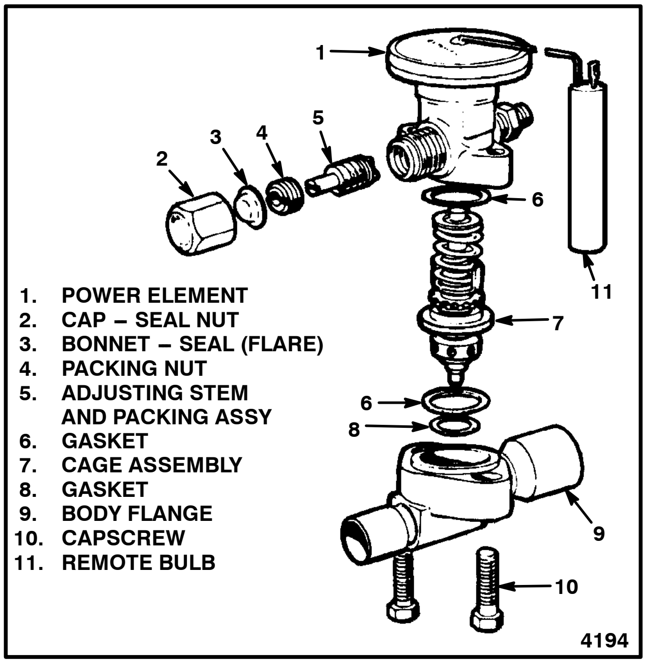
EXPANSION VALVE

The expansion valve (Figure 19) is a thermo-sensitive adjustable-spring expansion valve (TEV). This type valve regulates the flow of liquid refrigerant into the evaporator coil proportional to the refrigerant gas temperature leaving the evaporator (i.e. superheat temperatures). The expansion valves used with R-22 refrigerant can be identified by a green colored decal on the power head.

The valve has a remote sensing bulb attached near the evaporator outlet to monitor superheat temperatures. The bulb is filled with a specific thermostatic charge which reacts proportionally to the superheat temperature. As the refrigerant's temperature increases, so does the pressure inside the bulb and diaphragm.

The sensing bulb and diaphragm are commonly referred to as the thermostatic element. The thermostatic element's diaphragm is the actuating member of the valve. Its motion is transmitted to the pin and pin carrier assembly by a pushrod, allowing the pin to move in and out of the valve's port, thereby allowing or blocking the refrigerant flow.

A superheat spring is located under the pin and carrier, and a spring guide sets it in place. This spring retains the valve pin under system pressures, assuring that only the superheat temperatures will open the valve. The valve also has an external valve adjustment mechanism for adjusting superheat bulb pressures.



1. POWER ELEMENT
2. CAP – SEAL NUT
3. BONNET – SEAL (FLARE)
4. PACKING NUT
5. ADJUSTING STEM AND PACKING ASSY
6. GASKET
7. CAGE ASSEMBLY
8. GASKET
9. BODY FLANGE
10. CAPSCREW
11. REMOTE BULB

Figure 19. Expansion Valve

Operation

Vapor is superheated when its temperature is higher than the saturation temperature corresponding to its pressure. The amount of the superheat is the temperature increase above the saturation temperature at a given pressure.

As the refrigerant moves along in the evaporator, the liquid boils off into a vapor and the amount of liquid decreases until all the liquid has evaporated due to the absorption of a quantity of heat from the surrounding atmosphere equal to the latent heat of vaporization of the refrigerant. The refrigerant gas continues along in the evaporator and remains at the same pressure; however, its temperature increases due to the continued absorption of heat from the surrounding atmosphere. The degree to which the refrigerant gas is superheated is a function of the amount of refrigerant being fed to the evaporator and the load to which the evaporator is exposed.

There are three fundamental pressures acting on the valve's diaphragm which affect its operation (Figure 20): sensing bulb pressure (A), equalizer (evaporator) pressure (B), and equivalent (superheat) spring pressure (C). The sensing bulb pressure is a function of the temperature of the thermostatic charge, i.e. bulb fill. This pressure acts on the top of the valve diaphragm causing the valve to move toward the open position. The equalizer and spring pressures act together underneath the diaphragm causing the valve to move toward a closed position. During normal valve operation, the sensing bulb pressure must equal the equalizer pressure plus the spring pressure, (i.e. A= B + C).

A change in refrigerant vapor temperature at the outlet of the evaporator is caused by one of two events: the spring pressure is altered by means of the valve adjustment, or the heat load on the evaporator changes. When spring pressure is increased by turning the valve adjustment clockwise, refrigerant flow into the evaporator is decreased. Vapor temperature at the evaporator outlet increases since the point where the refrigerant completely vaporizes moves further back within the evaporator, leaving more evaporator surface to heat the vapor. The actual refrigerant vapor and bulb temperature will be controlled at the point where bulb pressure balances with the sum of the equalizer and spring pressures. Conversely, decreasing spring pressure by turning the valve adjustment counter clockwise increases refrigerant flow into the evaporator and decreases refrigerant vapor and bulb temperatures Spring pressure determines the superheat at which the valve controls. Increasing spring pressure increases superheat, decreasing spring pressure decreases superheat.

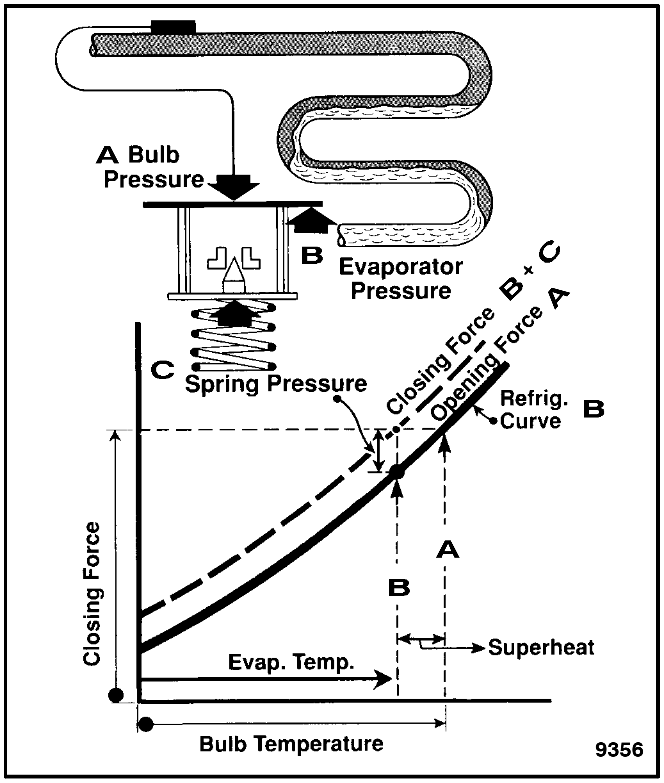


Figure 20. Fundamental Pressures

The spring is adjusted to give 15-18F° (8-10C°) of superheat heat at the evaporator outlet for R-22. This ensures the refrigerant leaving the evaporator is in a completely gaseous state when drawn into the suction side of the compressor. Liquid would damage the compressor valves, pistons and heads if allowed to return in the suction line.

An increase in the heat load on the evaporator causes refrigerant to evaporate at a faster rate. As a result, the point of complete vaporization of the refrigerant flow is moved further back within the evaporator. Refrigerant vapor and bulb temperatures increase, causing bulb pressure to rise and the valve to open until the three pressures are in balance. Conversely, a reduction in the heat load on the evaporator will cause the vapor and bulb temperature to fall and the valve to move to a closed position until pressures balance. Unlike a change in the spring pressure due to valve adjustment, a change in the heat load does not appreciably affect the superheat at which the thermostatic expansion valve controls.

Service

The expansion valves are factory set, however, due to the operations of the multiple evaporator installation, many factors can affect the performance of a valve. When the application or operating conditions require a different setting, the valve may be adjusted to obtain the required superheat.

Fittings are provided on the main and secondary (driver and parcel rack module) evaporator and equalizer lines to check the superheat temperatures. In order to determine if an expansion valve requires adjustment or other servicing, the evaporator superheat temperature must be obtained.

First use the “Superheat Calculation” procedure to find the superheat value. Secondly, this temperature should be verified by checking the suction superheat temperature using the “Restriction Check” procedure. After these procedures have been performed and the expansion valve still requires adjustment, adjust the superheat per the “Superheat Adjustment” procedure.

Superheat Calculation

1. Operate coach engine for at least one half hour at fast idle with temperature controls set at 82°F (27.8°C).

2. Attach a pressure gauge to the evaporator equalizer line check fitting of the expansion valve (Figure 21 22).

NOTE: The hose end with the valve stem depressor is connected to the fitting with the valve stem.

3. Install a remote reading thermometer to the evaporator outlet at or near the existing remote bulb.

NOTE: Thermostatic tape must be wrapped around the bulb, evaporator outlet line and gauge probe to get a true reading of the line temperature.

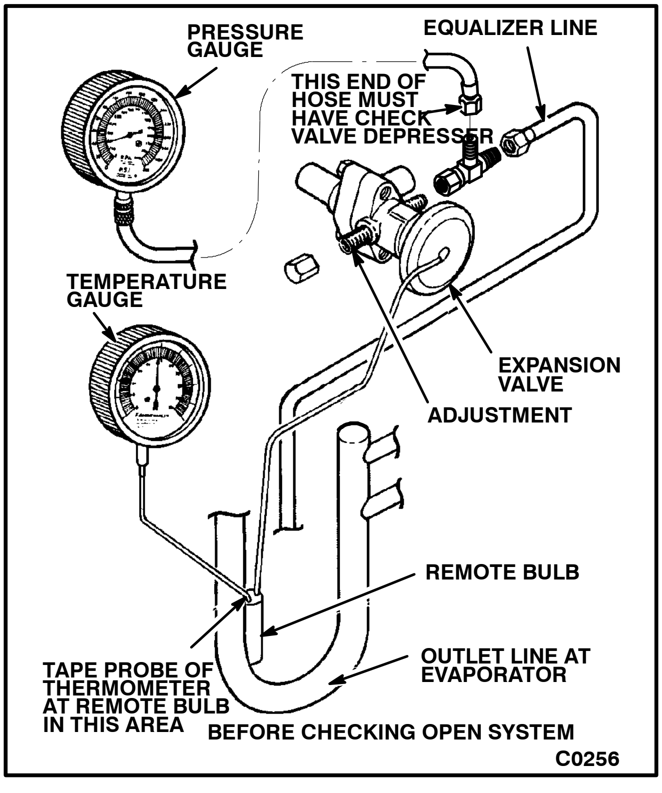

PRESSURE GAUGE
EQUALIZER LINE
THIS END OF HOSE MUST HAVE CHECK VALVE DEPRESSER
TEMPERATURE GAUGE
EXPANSION VALVE
ADJUSTMENT
REMOTE BULB
TAPE PROBE OF THERMOMETER AT REMOTE BULB IN THIS AREA
OUTLET LINE AT EVAPORATOR
BEFORE CHECKING OPEN SYSTEM
C0256

Figure 21. Superheat Gauge Location

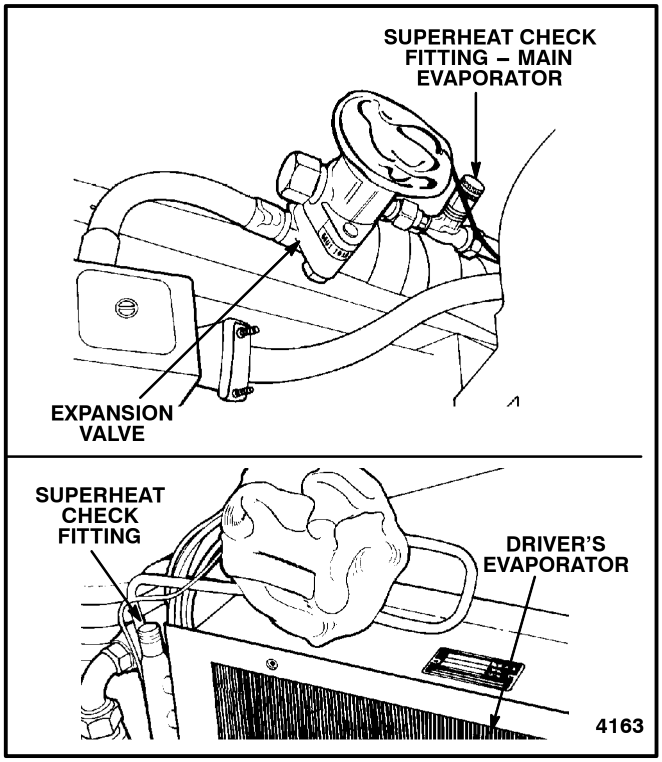

SUPERHEAT CHECK FITTING – MAIN EVAPORATOR
EXPANSION VALVE
SUPERHEAT CHECK FITTING
DRIVER’S EVAPORATOR
4163

Figure 22. Superheat Gauge Fittings

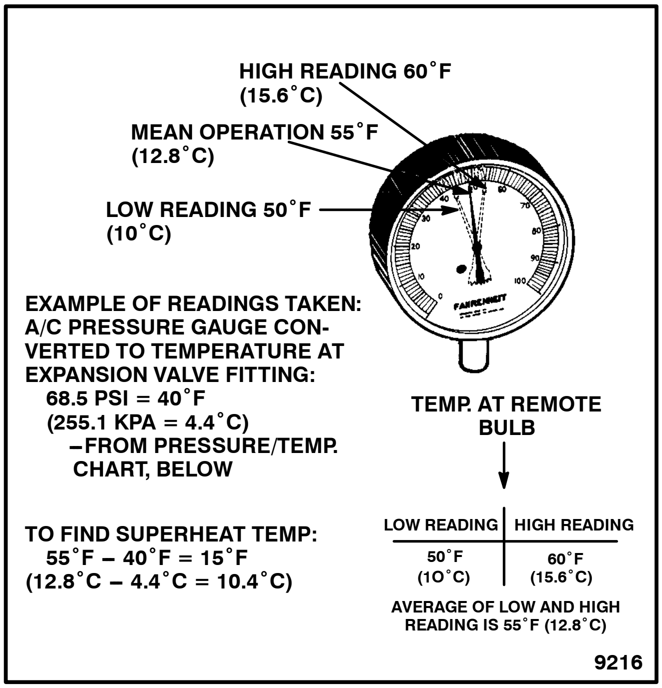

HIGH READING 60°F (15.6°C)
MEAN OPERATION 55°F (12.8°C)
LOW READING 50°F (10°C)
EXAMPLE OF READINGS TAKEN: A/C PRESSURE GAUGE CONVERTED TO TEMPERATURE AT EXPANSION VALVE FITTING:
68.5 PSI = 40°F
(255.1 KPA = 4.4°C)
–FROM PRESSURE/TEMP. CHART, BELOW
TEMP. AT REMOTE BULB
TO FIND SUPERHEAT TEMP:
55°F – 40°F = 15°F
(12.8°C – 4.4°C = 10.4°C)
LOW READING
HIGH READING
50°F (1O°C)
60°F (15.6°C)
AVERAGE OF LOW AND HIGH READING IS 55°F (12.8°C)
9216

Figure 23. Gauge Readings

4. Over an eight (8) minute operating period and at each two (2) minute interval, check and record the pressure reading. Also, record the highest and lowest temperature reading obtained during this eight minute period.

5. Find the equivalent temperatures for each of the pressures readings recorded using the Pressure to

Temperature Charts at the end of this section or a compound gauge (Figure 23).

NOTE: Examples shown are for R-22 refrigerant.

6. Determine the average equivalent check fitting temperature by adding the four temperatures and dividing the sum by four.

2 Minute	35°F. (2.0°C.)
4 Minute	40°F. (4.4°C.)
6 Minute	45°F. (7.2°C.)
8 Minute	50°F. (10 °C.)
TOTAL	160°F.(23.6°C.)

[160°F ÷ 4 = (40°F.) 23.6°C ÷ 4 = (5.9°C.)]

7. Determine the average remote bulb temperature by adding the high and low temperature readings and dividing the sum by two.

High	60°F. (15.6°C.)
Low	50°F. (10.0°C .)
TOTAL	110°F. (43.3°C.)

[110°F. ÷ 2 = (55°F.) 43.3°C. ÷ 2 = (22°C.)]

8. Subtract the average equivalent temperature (step 6) from the average bulb temperature (step 7).

Average Bulb Temperature	55°F (12.8°C.)
Average Equivalent Temperature	40°F (4.4°C.)
DIFFERENCE	15°F (8.4°C.)

NOTE: The superheat value will be shown as the difference. The superheat for R-22 refrigerant filled systems should be within a range from 15-18 °F. If more than 18 °F or less than 15 °F, the expansion valve requires adjustment and the entire procedure should be repeated. Refer to the Pressure Setting Chart that follows for other superheat temperature and pressure setting specifications.

Restriction Check

The following procedure is used to verify the need for expansion valve adjustment, and to assure that there is no restriction within the system. This procedure determines the system superheat and is to be performed only after the evaporator superheat has been calculated by the previous procedure.

1. Remove the gauges from the expansion valve and install them at the compressor service valve gauge connections.

NOTE: Install pressure gauge to suction line and temperature probe installed just ahead of the compressor to indicate suction line temperature.

2. Run the system for 10 minutes with temperature control set at 82°F. (28°C.).

3. Measure and record the line pressure and temperature.

4. Determine equivalent temperature of the gauge pressure obtained from the chart.

EXAMPLE: 68.5 psi (472.3 kPa) equals 40°F. (4.4°C.)

5. Subtract the equivalent temperature from the line temperature obtained by the temperature probe.

Probe Temperature Reading	55°F. (12.8°C.)
Equivalent Temperature	40°F. (4.4°C.)
ANSWER	15°F. (8.4°C.)

The answer will represent the suction superheat. If this temperature is approximately equal to the superheat temperature obtained through the “Superheat Calculation”, there is no apparent restriction in the suction line or filter dryer, nor is there a valve restriction.

If the answer is not approximately equal to the evaporator superheat temperature, determine the cause of the different readings (e.g., suction line restriction, clogged filter dryer or valve restriction) and correct. Repeat steps 1-5 to determine the need for expansion valve adjustment.

⚠ CAUTION ⚠

If an expansion valve is suspected of being out of adjustment, first check system for a restricted suction line, plugged filter-dryer or a partially open solenoid valve before starting a “Superheat Adjustment” procedure.

If an expansion valve is suspected of being blocked, close the valve by turning clockwise, reopen fully and then reclose. After reclosing. return the valve to the original position and check superheat settings with system specifications.

NOTE: Count the number of full turns that it takes to fully close the valve the first time, so it can be returned to approximately the same start position.

Adjusting Superheat

1. To readjust the superheat setting, remove the adjustment screw cover side cap or bottom plug.

NOTE: The main and parcel rack evaporator expansion valves have straight blade adjusting screws, while the driver evaporator expansion valve has an adjusting hex socket.

2. Turn the adjustment screw or hex clockwise to increase superheat temperature, or counterclockwise to lower superheat temperature.

NOTE: Always allow the system to equalize for approximately 10 minutes after making superheat adjustments before rechecking values.

15. Recheck the superheat values using the "Superheat Calculation" and/or "Restriction Check" procedure

Expansion Valve Inspection and Cleaning

1. Pump down the system as directed earlier in this section.

2. At the expansion valve, disconnect the external equalizer line from the underside of the power head and unclamp the remote control bulb from the evaporator coil outlet line (Figures 21 and 22).

3. Remove the two capscrews holding the power assembly to the valve body flange. Lift off the power assembly and remove the cage assembly.

4. Thoroughly clean all parts with mineral spirits and stiff bristle (not steel) brush. Dry thoroughly with compressed air.

⚠ CAUTION ⚠

Do not use gasoline, naphtha, carbon tetrachloride or similar solvents to clean parts. Do not use steam or caustic materials for cleaning.

5. Inspect all parts for wear, pitting, scoring, cracks or distortion. Remote bulb and connecting tube must be free of cracks, holes, kinks and cuts.

When reassembling, replace with new gaskets in proper place. Be sure the two lugs on the cage assembly fit into grooves provided in the power assembly. Do not force the valve together. The cage must fit properly before tightening the body flange. Tighten bolts evenly.

⚠ CAUTION ⚠

If necessary to make a soldered connection, first remove the power and cage assemblies and all gaskets. Keep heat away from all parts except the body flange, particularly the remote control bulb and tube.

MAIN (PASSENGER'S) VENTILATION

The main air ventilation system utilizes sidewall circulation of the interior air supply. These air passages are somewhat accessible to passengers, and can become blocked with refuse or debris. Periodic (seasonal) inspection and/or cleaning of these air passages to maintain fresh air flow may be required.

NOTE: Trash guards for sidewall passageways are available as optional equipment.

The main ram air system utilizes a butterfly valve assembly to control the amount of air that enters the main HVAC system (Figure 24). Periodic (seasonal) inspection or cleaning of the valve to maintain fresh air flow may be required. To service the valve or air cylinder follow the procedures in order.

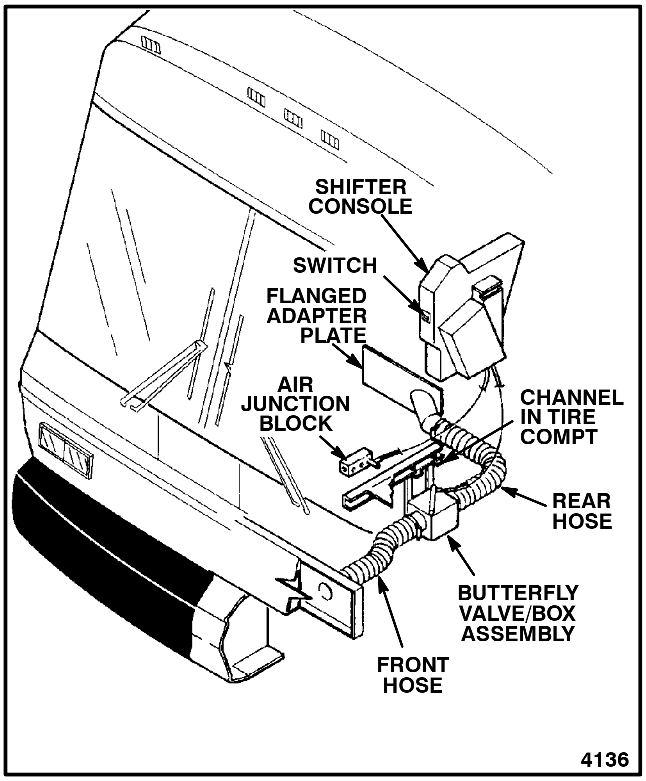


Figure 24. Ram Air Intake

Valve Replacement

1. Turn battery switch to "Off" position.

2. Exhaust valve's air cylinder by pressing switch on driver's console.

3. Open the front side service door, and disconnect the hose clamps and hoses from valve box.

4. Unfasten and remove the air line from air cylinder.

5. Unfasten and remove the valve mounting brackets from the coach frame, and remove valve with air cylinder attached.

6. Install valve in reverse order of the removal procedure and test.

SECONDARY (DRIVER'S) VENTILATION

Secondary (Driver's) Ram Air

The secondary (driver's) HVAC module incorporates a ram air damper for fresh air distribution to the driver's area and windshield. Opening the damper allows more outside air to be drawn into the driver's heating and defrosting system, where it is mixed with recirculated air and distributed through the heater and defroster ducts.

Periodic (seasonal) inspection or cleaning of the ram air plenum to maintain fresh air flow may be required. No other maintenance requirements are needed for the module's damper aside from minor adjustment of the control cable and interior foam seal replacement.

Control Cable Removal

A driver's fresh air control cable assembly is located on the floor to the left of the driver's seat. The cable mounts to the driver's module damper on one end, and to the driver foot rest cable mounting bracket on the other end. The cable runs under the floor in the tire compartment. To replace the cable follow this procedure in order.

1. Unfasten and remove the handle from the control cable.
2. Remove lower dash cover on the driver's module, and open interior cover.
3. Unfasten and remove control cable from damper attachment points.
4. Unfasten and remove the hex nut mounting the cable to the foot rest bracket.
5. Unfasten and remove the cable mounting clips in tire compartment and pull cable through floor holes.

Control Cable Installation

1. Install cable in reverse order of the removal procedure and test.

SECONDARY (PARCEL RACK) BLOWERS

Extra air circulation is provided by the parcel rack module's ventilation system. The module's blower forces air into the parcel rack's air duct, and the air is expelled through the service module's vent valves.

Replacement

1. Turn battery switch to "Off" position.
2. Remove the parcel rack module door.
3. Unfasten and remove the blower mounting bolts and rubber noise isolators.
4. Unfasten the electrical harness from the blower motor.
5. Lift the motor, housing and impeller out of the module.
6. Install blower in reverse order of the removal procedure.

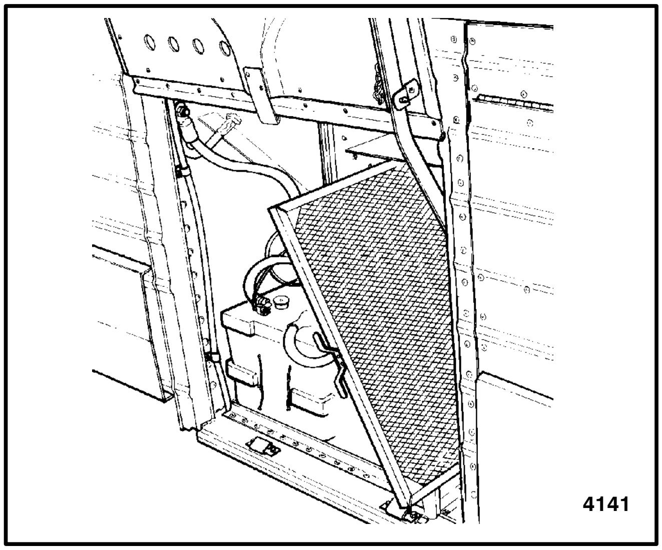


Figure 25. Air Filter

AIR FILTERS

The entire air supply of the coach passes through filter assemblies located in the main and secondary HVAC modules or compartments (Figures 25). These filters are removable and should be periodically, washed and/or replaced. Use the following procedures to remove and clean filters.

NOTE: Effective with unit 47071 coaches are fitted with either a reusable metal screen type filter (Figure 26) or have a throw-away media element.

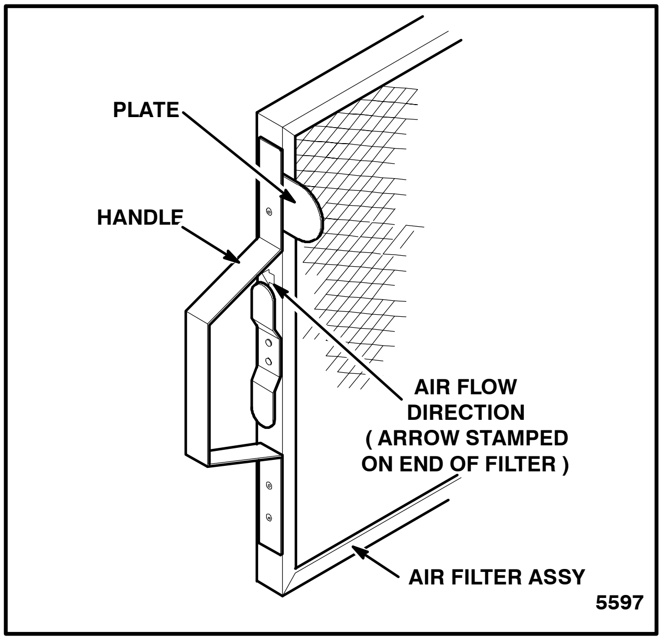


Figure 26. Air Filter Assembly with Stop Plate

Main HVAC Filter

1. Open the battery compartment and filter compartment door, unlatch locks holding filter in place and pull out. The filter is provided with a grab handle for ease of removal.

2. If disposable type filter, remove filter media retainer, discard filter and replace with new material. If metal type, shake out excessive dirt and grit.

NOTE: Media type filter material may be washed and reused if replacement is not available.

3. Wash in warm water, and if excessively dirty, use a mild laundry detergent in warm water.

4. Rinse thoroughly and shake out excess water.

5. Let dry and reinstall.

NOTE: The metal air filter air flow direction arrow is stamped into the handle.

⚠ CAUTION ⚠

The coach should never be operated without the main filter assembly securely in place. Air could bypass from pressure to the suction side of plenum, causing circulation to be impaired and efficiency reduced.

Secondary (Driver's) Filter Assembly

1. Remove front lower dash panel and inner module cover.

2. Unfasten filter clips and remove filter.

3. Shake out excessive dirt and grit.

4. Wash in warm water, if excessively dirty use a mild laundry detergent in warm water, let dry and reinstall.

Secondary (Parcel Rack) Filter Assembly

1. Open parcel rack door and prop door.

2. Unfasten filter clips and remove filter.

3. Shake out excessive dirt and grit.

4. Wash in warm water, and if excessively dirty, use a mild laundry detergent in warm water.

5. Wash in warm water, if excessively dirty use a mild laundry detergent in warm water, let dry and reinstall.

Test & Service Equipment

Specific air conditioning test equipment is recommended for routine service or superheat adjustment on the air conditioning system. It includes the following:

R-22 & R-134A System

Qty.	Part No.	Description
1	NPN	Electronic Leak Detector
3	16C-2-95	Charging Hoses
1	NPN	Pressure Gauge 0–600 lb
1	16C-2-97	Compound Gauge 0–150/30 lb
1	16C-2-98	Gauge Manifold
1	16C-2-99	Thermometer Without Probe
1	NPN	Thermometer W/Remote Probe

R-22 CONVERSION CHART PRESSURE TEMPERATURE

°F	°C	POUNDS	kPa
−10	−23.3	16.5	113.8
−8	−22.2	17.9	123.4
−6	−21.1	19.3	133.1
−4	−20.0	20.8	143.4
−2	−18.9	22.4	154.4
0	−17.8	24.0	165.5
2	-16.7	25.6	176.5
4	−15.6	27.3	188.2
6	−14.4	29.1	200.6
8	−13.3	30.9	213.0
10	−12.2	32.8	226.1
12	−11.1	34.7	239.2
14	−10.0	36.7	253.0
16	−8.9	38.7	266.8
18	−7.8	40.9	282.0
20	−6.7	43.0	296.5
22	−5.6	45.3	312.3
24	−4.4	47.6	328.2
26	−3.3	49.9	344.1
28	−2.2	52.4	361.3
29	−1.7	53.7	370.2
30	−1.1	54.9	378.5
31	−0.6	56.2	387.5
32	0.0	57.5	396.4
33	0.6	58.8	405.4
34	1.1	60.2	414.4
35	1.7	61.5	424.0
36	2.2	62.9	433.0
37	2.8	64.3	443.3
38	3.3	65.7	452.3
39	3.9	67.1	462.6
40	4.4	68.6	472.3
41	5.0	70.0	482.6
42	5.6	71.5	492.9
43	6.1	73.0	503.3
44	6.7	74.5	513.6
45	7.2	76.1	524.7
50	10.0	84.1	579.8
60	15.6	101.6	700.5
70	21.1	121.5	837.7
80	26.7	143.7	990.7
90	32.1	168.4	1161.0
100	37.8	196.0	1351.3

R-134 CONVERSION CHART PRESSURE TEMPERATURE

°F	°C	POUNDS	kPa
−10	−23.3	2.0	13.8
−8	−22.2	2.9	19.9
−6	−21.1	3.7	25.5
−4	−20.0	4.6	31.7
−2	−18.9	5.6	38.6
0	−17.8	6.6	45.5
2	-16.7	7.6	52.4
4	−15.6	8.6	59.3
6	−14.4	9.7	66.8
8	−13.3	10.8	74.4
10	−12.2	12.0	82.7
12	−11.1	13.2	91.0
14	−10.0	14.5	99.9
16	−8.9	15.8	108.9
18	−7.8	17.1	117.9
20	−6.7	18.5	127.5
22	−5.6	19.9	137.2
24	−4.4	21.4	147.5
26	−3.3	22.9	157.8
28	−2.2	24.5	168.9
29	−1.7	25.3	174.4
30	−1.1	26.1	179.9
31	−0.6	27.0	186.1
32	0.0	27.8	191.6
33	0.6	28.7	197.8
34	1.1	29.6	204.0
35	1.7	30.4	209.6
36	2.2	31.3	215.8
37	2.8	32.3	222.6
38	3.3	33.2	228.9
39	3.9	34.1	235.1
40	4.4	35.1	242.0
41	5	36.1	248.9
42	5.6	37.0	255.1
43	6.1	38.0	261.9
44	6.7	39.1	269.5
45	7.2	40.1	276.5
50	10.0	45.5	313.7
60	15.6	57.4	395.7
70	21.1	71.1	490.2
80	26.7	86.7	597.7
90	32.1	104.3	719.1
100	37.8	124.2	856.3

PRESSURE SETTINGS FOR OTHER A/C SYSTEM COMPONENTS R-22

High Pressure Cut-Out Switch	Open @ 450/325
Low Pressure Cut-Out Switch	Open @ 50/35
Receiver Tank	MAWP: 575 psi
Unloaders	65/58 58/48
Expansion Valve Cage	10 Ton
Superheat Main & Secondary	15-18 °F

PRESSURE SETTINGS FOR OTHER A/C SYSTEM COMPONENTS R-134A

High Pressure Cut-Out Switch	Open @ 300/200
Low Pressure Cut-Out Switch	Open @ 50/35
Receiver Tank	MAWP: 575 psi
Unloaders	36/28 28/22
Expansion Valve Cage	10 Ton
Superheat Main & Secondary	12 °F

EXPANSION VALVE TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
LOW SUCTION PRESSURE, HIGH SUPERHEAT	Expansion valve limiting flow or adjustment too low.	Adjust and/or test expansion valve.
	Inlet pressure too low from excessive vertical lift, undersize liquid line or excessive low condensing temperature. Resulting pressure difference across valve too small.	1. Increase head pressure. 2. If liquid line is too small, replace with proper size.
	Gas in liquid line due to pressure drop in the line or insufficient refrigerant charge.	Locate cause of liquid line flash and correct by use of the following methods: (1) Add charge (2) Replace or clean filter dryer. (3) Check for proper line size.
	Valve orifice too small	Replace with proper valve.
	Superheat adjustment too high.	Adjust superheat as outlined under Superheat Adjustment.
	Power assembly failure or partial loss of charge.	Replace power assembly or replace valve.
	Air filter screen clogged.	Clean or replace air filter screen
	King valve at liquid receiver too small or not fully opened. Hand valve stem failure or valve too small or not fully opened.	1. Discharge or suction service valve on compressor restricted or not fully opened. 2. Repair or replace faulty valve if it cannot be fully opened. 3. Replace any undersize valve with one of correct size.
	Plugged lines.	Clean, repair or replace lines.
	Liquid line too small.	Install proper size liquid line.
	Suction line too small	Install proper size suction line.
	Compressor discharge valve leaking.	Replace or repair valve.
LOW SUCTION PRESSURE, LOW SUPERHEAT	Wrong compressor pulley size.	Install proper size pulley.
	Uneven or inadequate loading due to poor air distribution or liquid flow.	Balance evaporator load distribution by providing correct air or liquid distribution.
	Valve superheat setting too low.	Adjust superheat as outlined under Superheat Adjustment.
	Compressor discharge valves leaking.	Replace or repair discharge valve.

EXPANSION VALVE TROUBLESHOOTING (Contd.)

TROUBLE	PROBABLE CAUSE	REMEDY
FLUCTUATING SUCTION PRESSURE	Incorrect superheat adjustment.	Adjust superheat to 8-12°F (4.4-6.7C°)
FLUCTUATING DISCHARGE PRESSURE	Insufficient charge	Add charge to system.
HIGH DISCHARGE PRESSURE	Air or non-condensable gases in condenser.	Purge and recharge system.
	Overcharge of refrigerant.	Bleed to proper charge.
	Condenser dirty.	Clean condenser.
	Insufficient cooling air distribution over air cooled condenser.	Properly locate condenser to freely dispel hot discharge air.

A/C SYSTEM TROUBLESHOOTING

LOW SUCTION PRESSURE AND FROSTING AT DRYER OUTLET	Clogged filter-dryer element.	Clean/Replace filter element.
LOW OIL LEVEL		Check for oil leaks and for a leaking oil seal. Do not attempt to check oil level unless system has been stabilized at least 20 minutes.
EXCESSIVELY COLD SUCTION LINE	Loss of contact between the expansion valve bulb and the suction line or sticking of the expansion valve.	Check for foreign matter and clean, repair or replace valve.
EXCESSIVELY COLD SUCTION LINE AND NOISY COMPRESSOR		1. Check superheat adjustment. 2. Check remote bulb contact. 3. Check expansion valve for sticking.
COMPRESSOR SQUEAKS OR SQUEALS WHEN RUNNING		1. Check oil level. 2. Replace oil seal.
NOISY OR KNOCKING COMPRESSOR		1. Check for broken internal parts. 2. Overhaul if required.
COMPRESSOR VIBRATES		Check and tighten compressor mounting bolts.
EXCESSIVELY HOT CONDENSER AND HIGH DISCHARGE PRESSURE	Air or non-condensable gas in system	Purge system.
LOW REFRIGERANT LEVEL		Check for refrigerant leaks and add refrigerant if required.

A/C SYSTEM TROUBLESHOOTING (Contd.)

TROUBLE	PROBABLE CAUSE	REMEDY
SUCTION PRESSURE RISES FASTER THAN 5 POUNDS PER MINUTE AFTER SHUTDOWN		Check compressor valve for breakage or damage.
INSUFFICIENT COOLING		1. Check for refrigerant leaks. 2. Check condition of filter screens and motors.
INSUFFICIENT AIR FLOW	Dirty or iced evaporator. Dirty air filter. Blowers inactive. Clogged ducts.	1. Check and clean evaporator,filters, ducts. 2. Recycle system.
FLOW OF REFRIGERANT THROUGH EXPANSION VALVE	Dehydrator strainer is clogged. Remote bulb has lost charge. Expansion valve is defective.	1. Clean strainer. 2. Replace remote bulb and/or expansion valve.
EXPANSION VALVE HISSES BUBBLES IN MOISTURE AND LIQUID INDICATOR	Gas in liquid line.	Add refrigerant.
LOSS OF CAPACITY	Clogged dehydrator. Obstructed or defective expansion valve.	Check and clean as required.
SUPERHEAT TOO HIGH		1. Reset superheat adjustment. 2. Check for clogged external equalizer line, or dehydrator.
REDUCED AIR FLOW	Dirty or clogged air filter C/H blower inoperative Plugged return air ducts Dirty or iced evaporator coil.	1. Clean air filter screen. 2. Check return ducts for obstructions. 3. Check blower motor.
TOO FREQUENT STARTING AND STOPPING ON LOW PRESSURE CONTROL SWITCH	Lack of refrigerant.	1. Check for leaks. 2. Recharge.
COMPRESSOR INTERMITTENTLY STARTS AND STOPS	Intermittent contact in electrical control circuit. Compressor valves not in operating position.	1. Check control circuit components. 2. Check compressor valve operation.
FREQUENT STARTING AND STOPPING	Low pressure switch controller differential set too close.	Check and adjust.
	High pressure switch controls differential too close.	Replace switch assembly.

SPECIFICATIONS

COMPRESSOR

Manufacturer	Carrier Transicold
Model	05G
Capacity (R-22)	37 CFM
Capacity (R-134A)	37 & 41 CFM
Part Number (W/R-22–37 CFM Mechanical Unloaders & Old Oil Pump Housing)	16J-2-22
Part Number (W/R-22–37 CFM Electric Unloaders & New Low Profile Oil Pump Housing)	16L-2-33
Part Number (W/R-134A–41 CFM Electric Unloaders & New Low Profile Oil Pump Housing)	16L-2-40
Cylinders	6
Bore	2 inches (50.8 mm)
Stroke	1-15/16 inches (49.2 mm)
Operating Speed	400 to 2000 rpm
Horsepower	25 (nominal)
Oil Pressure	15 to 30 psi (103.5-207 kPa) (1750 rpm)
Oil Change	6-3/4 pints (3.19 liters)
Weight	145 lb. (64.5 kg)

COMPRESSOR OIL

DuPont (R-22)	Zephron 150
Sunoco (R-22)	Sunisco 3GS
Texaco (R-22)	WF1 132 WF68
Castrol (R-134A)	SW-68 (Icematic)

APPROVED CLUTCH GREASE

Chevron	SR-1 or SR-2

REFRIGERANT CAPACITY

R-22 Refrigerant (102DL3 With Parcel Rack A/C)	26 lbs. (11.5 kg)
R-22 Refrigerant (102D3)	24 lbs. (10.8 kg)
R-134A Refrigerant (102DL3 With Parcel Rack A/C)	36 lbs. (16.2 kg)
R-134A Refrigerant (102D3)	28 lbs. (12.9 kg)

RECEIVER TANK

Manufacturer	Nelson
Part Number	16L-5-83

CONDENSER COIL

Manufacturer	Trane
Part Number (R-22)	16J-4-1
Part Number (R-134) (Effective With Unit 47071)	16L-4-64

EVAPORATOR COIL

Manufacturer	Carrier
Part Number (R-22)	16R-6-1
Part Number (R-134) (Effective With Unit 47071)	16L-7-107

SPECIFICATIONS (Contd.)

CONDENSER FAN MOTOR

Manufacturer	Reliance Electric
Part Number (Basic).	16J-9-1
Part Number (Corrosion Resistant) (Effective With Unit 49369)	16L-9-8
Type	Dual-Speed Single-Shaft
Horsepower	2 hp (Continuous Duty)
Volts	24-Volts
Amperage Draw	65 Amp
RPM	2300

EVAPORATOR BLOWER MOTOR

Manufacturer	Reliance Electric
Part Number.	16L-8-5
Type	Two-Speed Twin-Shaft
Horsepower	1-1/2 hp (Continuous Duty)
Volts	24-Volts
Amperage Draw	68 (High Speed)/29.6 (Low Speed)
RPM	3060 (High Speed)/2250 (Low Speed)

FILTER DRYER

Manufacturer	Sporlan
Part Number.	16J-10-3

HIGH PRESSURE SWITCH (CLUTCH CUT-OUT)

Part Number (R-22 W/Manual Unloaders)	16K-10-8
Part Number (R-22 W/Electric Unloaders)	16L-10-110
Part Number (R-134A W/Electric Unloaders)	16L-2-34

LOW PRESSURE SWITCH (CLUTCH CUT-OUT)

Part Number (R-22 W/Manual Unloaders)	16L-10-25
Part Number (R-22 W/Electric Unloaders)	16L-2-55
Part Number (R-134A W/Electric Unloaders)	16L-2-55

SECTION 16C

AIR CONDITIONING COMPRESSOR

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Maintenance 16C-4
Miscellaneous Torque Specifications 16C-24
Component Wear Limits 16C-24
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GENERAL DESCRIPTION

The 102D series coaches are fitted with the Carrier Model 05G air conditioning refrigerant. The compressor is a two-stage, six-cylinder, reciprocating-piston, positive-displacement type refrigerant compressor. The compressor is driven by belt off of the engine's crankshaft pulley. The compressor drive pulley is fitted with a housing mounted clutch assembly. The compressor is mounted on a pivoting, fully adjustable mounting frame, and can be accessed through the rear RH taillamp door.

The compressor housing provides for a common suction and discharge manifold for the right and left cylinder banks in the first stage of compressor operation. The compressor is equipped with flanges for connecting suction and discharge service valves. Sight glasses are installed on both sides of the crankcase to provide oil level viewing of the compressor crankcase. A drain and fill plug facilitate draining and addition of oil to the crankcase. A bottom plate provides access through the bottom of the crankcase for maintenance.

Compressor wear is minimized by use of pump and splash feed lubrication. Pressurized lubrication is accomplished by a low-speed oil pump driven directly from the end of the compressor crankshaft. Shaft seal assemblies prevents refrigerant and oil leakage where the shaft passes through the compressor housing.

The compressor pistons are aligned in three sets or banks of pistons. Each bank's set of pistons move in unison, with each bank operating in alternating sequence. The compressor uses reed-type suction and discharge valves made of highest quality steel for long life. The valves operate against hardened integral seats of the valve plates on each cylinder bank.

The compressor also utilizes bypass-type solenoid operated cylinder head unloaders to regulate the first stage compression of suction manifold gas in the right (curb side) and left (engine side) cylinder banks. The unloaders use thermostat actuated, spring returned, piston-type bypass to regulate gas flow into the discharge manifold, and thereby, into top cylinder bank for the second stage or final compression.

OPERATION

COMPRESSOR

The down-stroke of the right and left bank set of pistons pulls the refrigerant gas from the A/C system's suction line through the suction service valve and into the compressor housing's common suction gas manifold (Figure 1). Refrigerant gas from this manifold flows into the right and left bank cylinder heads and then through the suction reed valves.

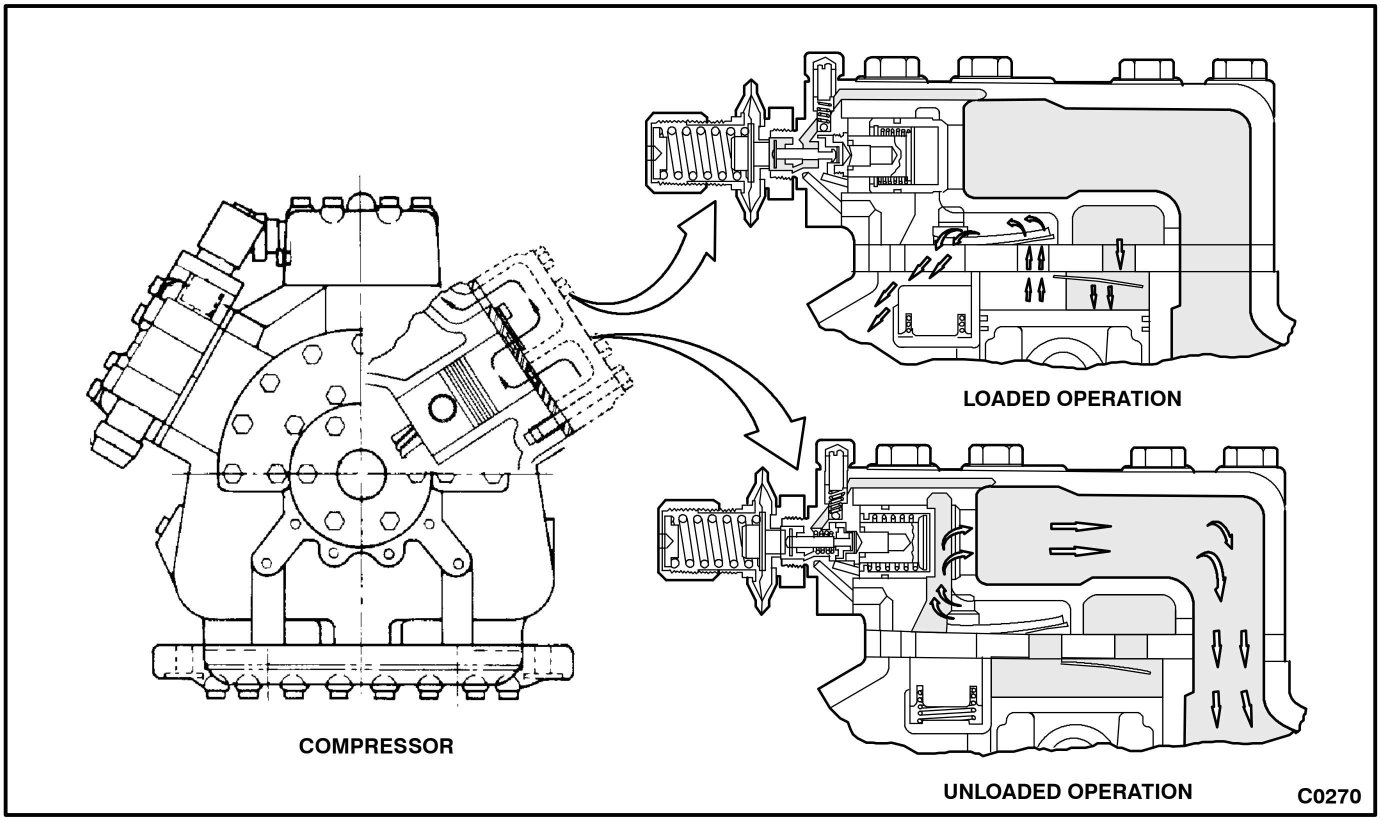


Figure 1. Compressor Operational Flow Diagram

The up-stroke of the pistons closes the suction reed valve and compress the gas. The compressed gas is then forced through the discharge reed valve, to either the discharge gas manifold located beneath the top bank cylinder head, or bypassed back into the right and left bank's suction gas manifold.

The down-stroke of the compressor's top bank pulls the partially compressed refrigerant gas from the discharge manifold through the cylinder head suction reed valves. The up-stroke of the piston closes the suction reed valve and compresses the gas further, thereby raising its pressure and temperature. The compressed gas is forced through the discharge reed valve, out of the top cylinder head and through the discharge service valve into the A/C system's discharge line.

All three cylinder bank suction and discharge valves operate in the same manner. The suction reed valves are located beneath the valve plate and attached to the compressor housing atop the cylinder head decks. The discharge reed valves are located on, and attached to the top of the valve plate.

UNLOADERS

Pressure Operated

The pressure-operated mechanical capacity control unloaders are controlled by suction pressure and actuated by discharge pressure. Each unloader valve controls two cylinders. On startup, controlled cylinders do not load up until differential between suction and discharge pressure is 10 psi (69 kPa).

During loaded operation the suction pressure is above the valve control set point. This causes the power head actuated poppet valve to close, thereby opening the bleed orifice to the bypass piston. Discharge gas pressure bleeds into the bypass piston chamber, and overcomes the bypass piston spring tension and closes the bypass piston against the cylinder head bypass passage. As the cylinder bank loads up the discharge gas pressure forces the check valve open, interconnecting the cylinder bank with the discharge manifold.

During unloaded operation the suction pressure drops below the valve control set point. This causes the poppet valve to open which closes the bleed orifice to the bypass piston.

The loss of pressure in the bypass piston allows the spring tension to pull the piston back, and thereby opens the bypass passage. Discharge from the cylinder bank is recirculated to the suction manifold to be reintroduced into the first stage compression sequence. A reduction in discharge pressure causes the check valve to close, isolating the cylinder bank from the discharge manifold.

Electrically Operated

Optional electrically operated capacity unloaders may be installed on the compressor. These normally-closed, electrically-operated, solenoid actuated, capacity control unloaders are controlled by a separate set of compressor pressure switches. The unloaders control the first stage discharge of both the right (curb side) and left (engine side) compressor cylinder banks.

Electrically-operated, unloader-controlled cylinder banks will not load-up or unload until demand for refrigeration, as sensed through pressure increases or decreases. As this happens, the switches, via ground, de-energizes or energizes the unloader solenoid, which allows discharge gas to circulate as shown in the flow diagrams for loaded and unloaded conditions.

During loaded operations, discharge pressure bleeds from the manifold through the bleed orifice into the solenoid valve stem chamber and the back of the bypass piston. The de-energized unloader valve stem blocks the bypass port for bleed orifice pressure. This pressure overcomes the bypass piston spring tension, and closes the bypass piston against the cylinder head bypass passage.

As the cylinder bank loads up, the compressed gas forces the discharge reed valve open and allows gas to enter the discharge check valve passage. The increased discharge pressures cause the check valve to open allowing the compressed gas to enter the discharge manifold.

During unloaded operation, the discharge pressure bleeds from the manifold through the bleed orifice into the solenoid valve stem chamber. The energized unloader valve stem opens the bypass port for bleed orifice pressure The loss of pressure in the bypass piston allow the spring tension to pull the piston back, thereby opening the bypass passage.

Discharge from the cylinder bank is recirculated to the suction manifold to be reintroduced into the first stage compression sequence. A reduction in discharge pressure causes the check valve to close isolating the cylinder bank from the discharge manifold.

SERVICE VALVES

The suction and discharge service valves of the A/C system are equipped with mating flanges for connecting to the compressor. Except for variations in the mounting flanges, (square vs oval), these valves are identical in construction. Both service valves are front and back seating type stop valves, and have provisions for gauge manifold connection for servicing of the compressor and/or system (Figure 2).

Valve Set-Up

Turning the valve stem counterclockwise (stem all the way out) back-seats the valve. Back-seating the valve should open the suction and/or discharge lines to the compressor and close off the service connection. The valve must be in this position during normal operation of the air conditioning system.

Turning the valve stem clockwise (stem all the way in) front-seats the valve. Front-seating the valve should close the suction and/or discharge lines, thereby isolating the compressor and opening the service connection. The valve would be placed in this position during a compressor removal or isolated testing and servicing procedures on the compressor.

⚠ CAUTION ⚠

Do not operate the compressor with the discharge service valve in the closed or front-seated position.

Turning the valve stem clockwise two to three full turns (stem approximately midway of travel) should position the valve between the front and rear seats. Positioning the valve in this manner would open the suction and/or discharge lines to both the compressor and the service connections.

For example, before connecting manifold and gauge set to suction and/or discharge service valves, ensure that the valve is fully back-seated. Connect the manifold and gauge set to service connection, and then either fully or partially front-seat the service valve for testing and/or servicing procedures on the compressor or the entire system.

COMPRESSOR CLUTCH

The air conditioning compressor clutch is an electrically operated, friction-faced clutch. When the air conditioning system is off, the clutch rotor (pulley) is free-wheeling and driven by coach engine through twin drive belts. When the A/C system temperature sensor actuates the system, the compressor clutch field coil is energized.

The magnetic field produced by the coil attracts the clutch armature engaging its face with the rotating face of the rotor. Since the armature is coupled directly to the compressor crankshaft, the compressor begins operating when the pulley transmits its rotation to the armature.

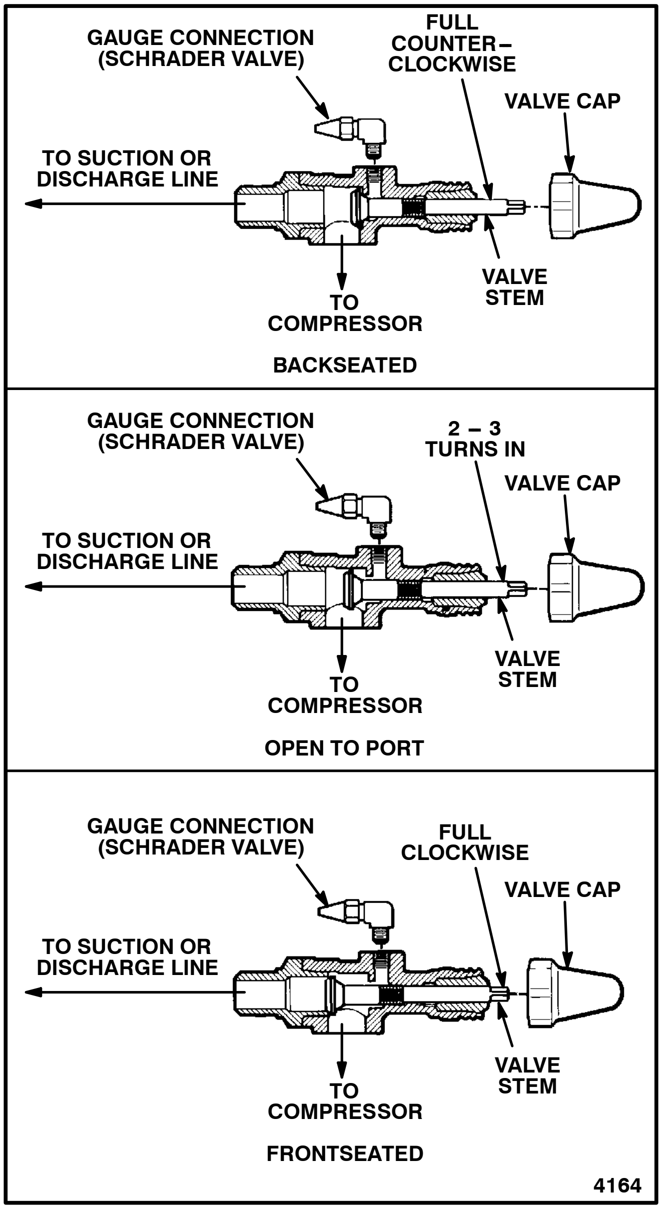

GAUGE CONNECTION (SCHRADER VALVE)
FULL COUNTER–CLOCKWISE
VALVE CAP
TO SUCTION OR DISCHARGE LINE
VALVE STEM
TO COMPRESSOR
BACKSEATED
GAUGE CONNECTION (SCHRADER VALVE)
2 – 3 TURNS IN
VALVE CAP
TO SUCTION OR DISCHARGE LINE
VALVE STEM
TO COMPRESSOR
OPEN TO PORT
GAUGE CONNECTION (SCHRADER VALVE)
FULL CLOCKWISE
VALVE CAP
TO SUCTION OR DISCHARGE LINE
VALVE STEM
TO COMPRESSOR
FRONTSEATED
4164

Figure 2. Service Valve Positions

The compressor will operate as long as the clutch field coil remains energized and armature and rotor are magnetically coupled. When the field coil is de-energized, the armature is pulled back out of contact with the rotor (by spring tabs) and the armature (and compressor shaft) ceases rotation.

NOTE: A housing-mounted clutch has 6 mounting nuts on the armature; a shaft-mounted clutch does not have these 6 nuts.

MAINTENANCE

LUBRICATION

Force feed lubrication of the compressor is accomplished by a low-speed oil pump driven directly from the compressor crankshaft. Refrigeration oil is drawn from the compressor crankcase through the oil filter screen and pick-up tube to the oil pump located in the bearing head assembly. The crankshaft is drilled to enable the pump to supply oil to the main bearings, connecting rod bearings, and the shaft seal. The lubricating oil is pumped, under pressure, through the lube system by a lobed rotor type oil pump.

The oil flows to the pump end main bearings, connecting rod bearings and seal end main bearings, where the oil path is divided into two directions. The largest quantity flows to the oil relief valve which regulates oil pressure at 15 to 18 psi (103.5-120.5 kPa) above suction pressure. When the oil pressure reaches 15 to 18 psi (103.5-120.5 kPa) above suction pressure, the relief valve spring is moved forward allowing oil to return to the crankcase. The remaining oil flows through an orifice and into the shaft seal cavity to provide shaft seal lubrication and cooling. This oil is then returned to the crankcase through an overflow passage (Figure 3).

An additional oil pressure relief valve, built into the oil pump, is open at speeds above 400 rpm to relieve a portion of the oil pressure to the crankcase in order to maintain oil pressure below an acceptable maximum. At low speeds, the valve is closed to ensure adequate oil pressure at 400 rpm. At speeds above 1 ,900 rpm, the oil pressure will be 25 to 30 psi (172.5-207 kPa) above suction pressure.

The oil pressure equalization system consists of two oil return check valves and a 1/8 inch pressure equalization port between the suction manifold and crankcase. Under normal conditions, check valves are open and allow for oil return to the crankcase. Under flooded start conditions, pressure rises in the crankcase and closes the check valves, preventing excess oil loss. The equalization port allows for release of excessive pressure, that has built up in the crankcase, to the suction manifold; this ensures that the oil loss is kept to a minimum.

The compressor oil levels should be checked every 100,000 miles (161,000 km) or 3,000 operating hours. On systems using R-22 refrigerant use lubrication specification S-22 (A/C Compressor Oil - Texico Capella D). On systems using R-134A refrigerant use lubrication specification S-28 (A/C Compressor Oil - Castrol - SW-68 (Icematic).

NOTE: Other lube oils may be substituted for lubrication specification S-22. Refer to the lubricant specification at the end of this section.

Compressor Oil Level Check

To perform this test use the following procedure:

1. Operate coach engine at fast idle with A/C switch “ON” for at least 20 minutes. Shut engine off.

2. Open rear and right side engine compartment doors. Sight gauges are located on both sides of compressor crankcase. Oil level is correct when engine side sight gauge is full and curb side sight gauge is empty.

3. If below correct oil level, check freon level before adding oil.

4. If adding oil is required, proceed with the following.

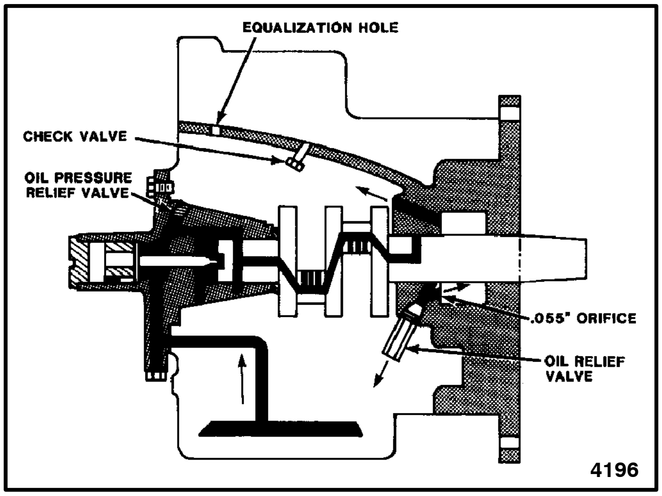


Figure 3. Compressor Lubrication Diagram

Adding Oil

1. Back-seat suction service valve and install low pressure service gauge hose onto suction service valve fitting. Front-seat both sides of service gauge. Attach hose to middle port of service gauge manifold and completely submerge the other end in oil supply.

2. Disconnect the liquid line solenoid valve.

3. Connect jumper wire to allow the clutch to remain engaged after pressure drops below the lowest set point.

NOTE: Compressor must be operated until system has been reduced from a pressure to a vacuum.

4. Front-seat suction service valve and crack open the low pressure service gauge to purge the oil supply line. After purging line, front-seat service gauge.

5. Start engine and turn on the air conditioning system.

6. When pressure in service gauge reads a vacuum, crack open the service gauge to allow oil to be drawn into compressor. When desired amount of oil is added, front-seat gauge.

7. Completely back-seat suction service valve, disconnect jumper and reconnect liquid line solenoid valve.

8. Run A/C system 15-20 minutes and check oil level.

9. Repeat procedure if level is too low..

NOTE: A pressurized oil pump that overcomes compressor pressure and forces oil into the crankcase may also be used. For further details, consult service department.

UNLOADER ADJUSTMENT

Pressure Operated

Before setting unloaders, install the service gauge set.

1. Turn large (1$\frac{1}{16}$ inch) load-up set point adjustment hexnuts on top of both unloaders clockwise to bottom stop. (Figure 4).

NOTE: On models equipped with unloader adjustment jamnuts (1/2 inch), turn these nuts clockwise to bottom stop, then turn the load-up adjustment hexnuts clockwise down against the jamnuts.

2. Remove sealing caps (unscrew counter-clockwise) that cover the pressure differential adjustment screws on side of both unloader flanges.

3. Turn both unloader differential screws clockwise to bottom stop.

4. Check oil lever in compressor sight glass and then start compressor.

5. Run compressor at fast idle for ten minutes.

NOTE: Steps 6 through 10 are to be followed for one unloader and then repeated for the other.

6. Slowly turn the suction service valve stem clockwise until the suction pressure is value “A” in the table below.

NOTE: At this point the difference between the discharge and suction pressures also must be at least 100-120 psig. It may be necessary to artificially load the system (i.e., block off condenser coil air flow or open hot water valve) to attain the required system pressures.

7. Turn the load-up adjustment nut on one unloader slowly counterclockwise while observing system

pressures, until the pressures "jump" (i.e., rapid decrease in suction pressure and increase in discharge pressure). The cylinder head is now loaded. Leave the adjustment nut this position.

8. Readjust the suction service valve until the suction pressure is value "B" in the table below.

9. Turn the pressure differential adjustment screw slowly counterclockwise until the pressures "jump" (i.e., rapid increase in suction pressure and decrease in discharge pressure). The cylinder head is now unloaded. Leave the adjustment screw in this position.

10. This unloader is now completely set. Check for repeatability by adjusting the suction service valve as necessary.

11. Repeat Steps 6 through 10 for the second unloader, using the corresponding values of "A" and "B" shown in the following table.

12. Reinstall the sealing caps that cover the differential adjustment screws, and tighten.

NOTE: On models equipped with unloader adjustment jamnuts, turn these nuts counterclockwise up tightly against the load-up adjustment hexnut, to "lock-in" unloader valve adjustment.

13. Turn both suction and discharge service valves fully counterclockwise and disconnect manifold gauge set.

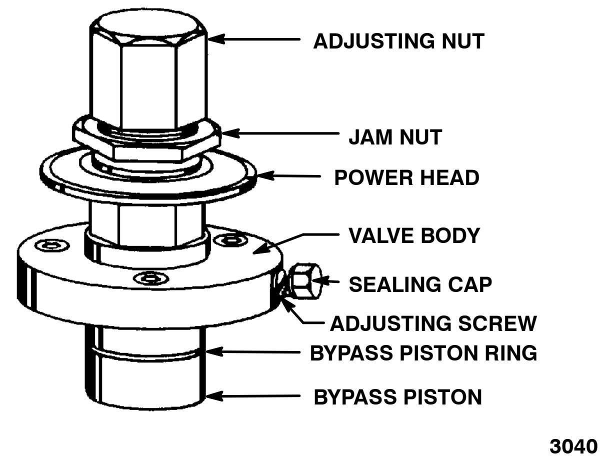


Figure 4. Unloader Assembly

RECOMMENDED SETTINGS (PSIG)

	Engine Side First Unloader		Curb Side Second Unloader	
Refrigerant	"A" (load up)	"B" (unload)	"A" (load up)	"B" (unload)
R-12	36	30	30	24
R-22	68	58	58	48
R-134A	36	28	28	22

Electrically Operated

Although the electric unloaders are non-adjustable, they will require some periodic maintenance. Service kits are available for repair of the electric unloaders solenoid and stem assemblies (Figure 5).

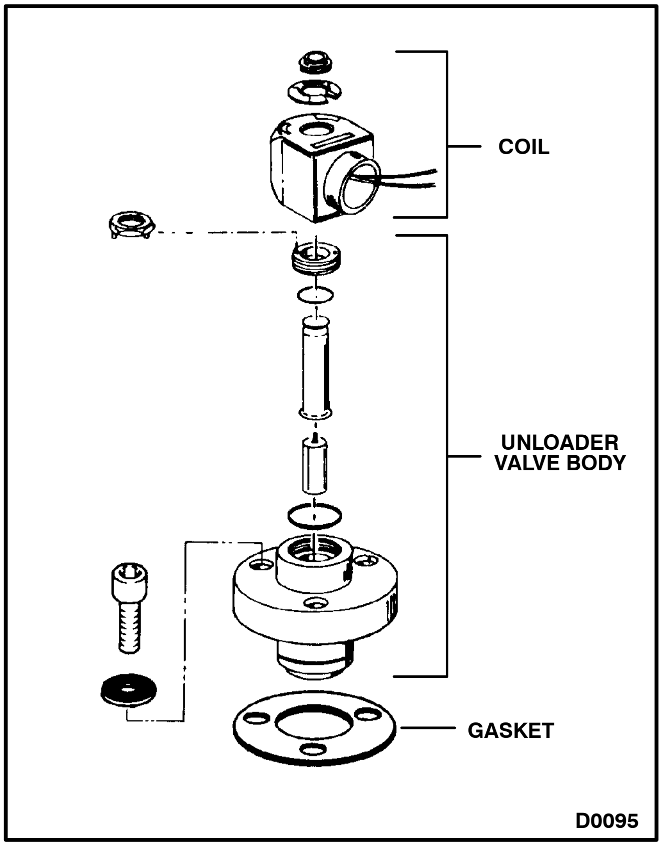


Figure 5. Solenoid-Operated Unloader

UNLOADER REMOVAL

1. Turn electrical switch to "OFF".

2. Completely front-seat both the suction and discharge service valves.

3. Unfasten the wire harness from the electrically operated unloader solenoids.

4. Unfasten and remove the capscrews retaining the unloader to the compressor and gently pull unloader out of cylinder head.

5. Thoroughly clean unloaders in solvent (MEK) and inspect for evidence of wear, pitting, spring weakness, etc.

UNLOADER INSTALLATION

NOTE: When installing new unloader gasket, align small crescent shaped cutouts with gas ports.

1. Install unloader by reverse removal procedure, and torque capscrews to 12-16 ft-lbs (16-22 N·m).

PRESSURE SWITCH TESTS

NOTE: Pressure switch settings are for R-22 refrigerant. Electric unloaders are controlled by a separate set of high and low pressure switches.

High Pressure Test

1. Connect high pressure service gauge to discharge service valve test fitting, and open or cover the condenser door to block air through condenser.

2. With engine operating at fast idle, high pressure switch should open at 340±10 psi (2,346±69 kPa), and cause compressor clutch to disengage.

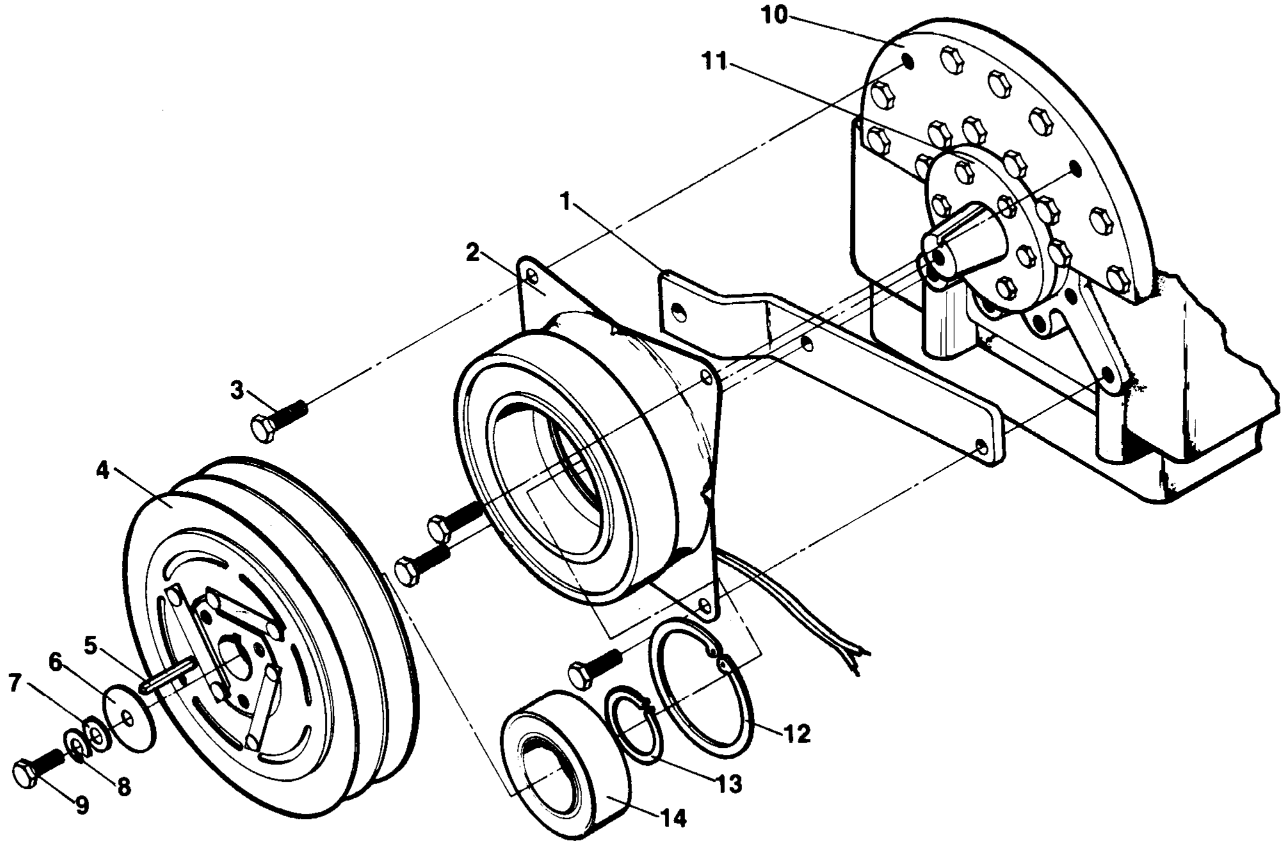
NOTE: When clutch is engaged, pulley and front plate rotate together. When clutch is disengaged only pulley will rotate.

3. Close or uncover the condenser door. Observe pressure gauge and front plate of clutch. At 190±10 psi (1,310±69 kPa) the pressure switch should close, and clutch should engage.

Low Pressure Test

1. Connect low pressure service gauge to suction service valve test fitting.

2. Partially frontseat the service valve until suction pressure reads 5±3 psi (34.5±20.7 kPa). Low pressure switch should open and the clutch should disengage.



1. A/C Belt Tension Cylinder Mtg. Brkt.
2. Coil
3. Capscrew, Mtg. Coil
4. Rotor and Armature Assembly
5. Key
6. Large Flat Washer
7. Small Flat Washer
8. Lock Washer
9. Capscrew, Mtg. Pulley
10. A/C Compressor Half Flange
11. Seal Cover Plate
12. Bearing Retaining Ring (Outer)
13. Bearing Retaining Ring (Inner)
14. Bearing

Figure 6. Shaft-Mounted Compressor Clutch

3. Slowly backseat the suction service valve while observing the service gauge and the front plate of the clutch. When the pressure reads 20±3 psi (137.9±20.7 kPa), the switch should close and the clutch should re-engage.

COMPRESSOR CLUTCH

Clutch Inspection (Shaft Mounted)

If the compressor clutch is mounted on the compressor shaft, the clutch bearing has no provision for lubrication (Figure 6). Maintenance of this unit is limited to inspecting the clutch for wear, replacing the clutch as required, and checking the resistance of the coil winding. For shaft-mounted compressor clutch, perform the following procedures

1. For the shaft-mounted clutch, clean all dirt and grease from the clutch armature plate. Take care not to allow the foreign material to be displaced into the armature slots and between clutch faces.

2. With compressed air, blow all dirt from clutch facing area.

3. Using a depth micrometer, measure and record the distance from the back of the armature to the face of the rotor (Figure 7).

4. Disconnect the clutch coil electrical lead. Ground one connector terminal and connect 24 VDC to the other terminal to energize the coil.

5. Repeat step 3 for the measured distance when the armature and rotor faces are engaged.

6. De-energize the coil and determine the difference between the two measurements.

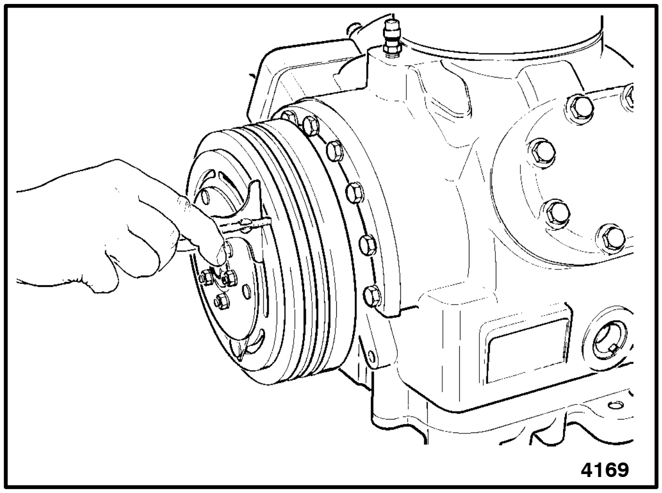


Figure 7. Armature-to-Rotor Clearance

NOTE: If the difference exceeds 0.11 inches (2.794 mm), the clutch rotor and armature require replacement. Proceed to step 7. If the distance is 0.11 inches (2.794 mm) or less, clutch wear indicates replacement is not necessary.

Clutch Removal (Shaft Mounted)

1. To remove the shaft-mounted clutch, first open the two way manual valve to vent air pressure from the drive belt tension air cylinder.

2. Remove the two compressor drive belts from the clutch rotor (pulley).

3. Disconnect the coil electrical lead.

4. Ensure that clutch rotor does not rotate, then remove the capscrew, lockwasher, and two flatwashers mounting clutch to compressor shaft.

⚠ CAUTION ⚠

Any bolts installed in the armature puller holes must have stop nuts in place to prevent insertion into armature more than 3/8 inch (95 mm). This will prevent damage to the bearing seal.

5. Remove the rotor and armature assembly, along with the locking key, from the compressor shaft.

6. Inspect the coil for damaged electrical leads, bent or cracked mounting plate, or cracked coil potting compound. Electrical resistance between connector terminals of the coil should be 5.15-5.69 ohms. Resistance from either terminal to the coil case (ground) should be infinite or open. Replace the coil if defective.

Clutch Installation(Shaft Mounted)

⚠ CAUTION ⚠

Before installing new clutch components, thoroughly clean compressor half flange and shaft seal cover plate of all dirt and grease. Use a clean cloth and suitable cleaning solvent. Dry cleaned surfaces thoroughly with compressed air.

1. To install the coil, place it over the shaft seal plate and align the mounting holes. Coil leads should be at the 4 o'clock position.

CAUTION

If the coil will not seat, do not draw it down flush by tightening the mounting capscrews. This will distort the coil mounting and cause misalignment between coil and clutch rotor.

2. When coil is capable of flush mounting, install belt tension cylinder mounting bracket and coil with the four capscrews. Tighten the capscrews to 25-30 ft-lbs (34-40 N·m) torque.

3. Install the rotor and armature assembly on the compressor shaft. Align the keyways and install the locking key, large and small flatwashers, lockwasher and capscrew. Hand tighten capscrew.

4. Insert a 0.02-inch (0.508 mm) feeler gauge between the O.D. of the coil and the coil cavity of the rotor (Figure 8). Holding the feeler in position, turn the rotor one revolution to check for proper coil-rotor clearance. If rotor turns freely, without binding, continue installation.

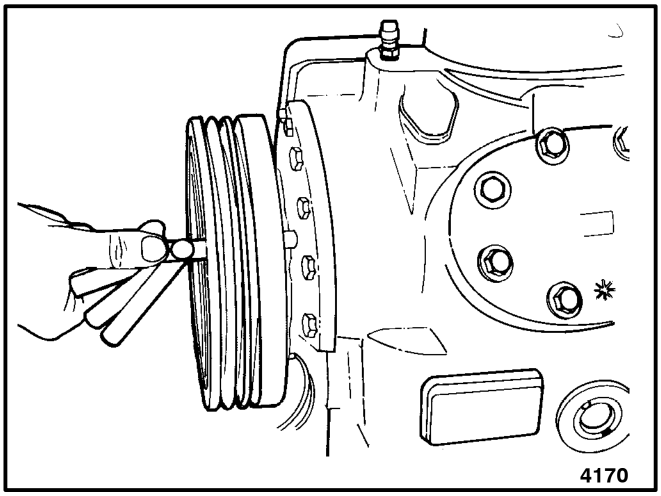
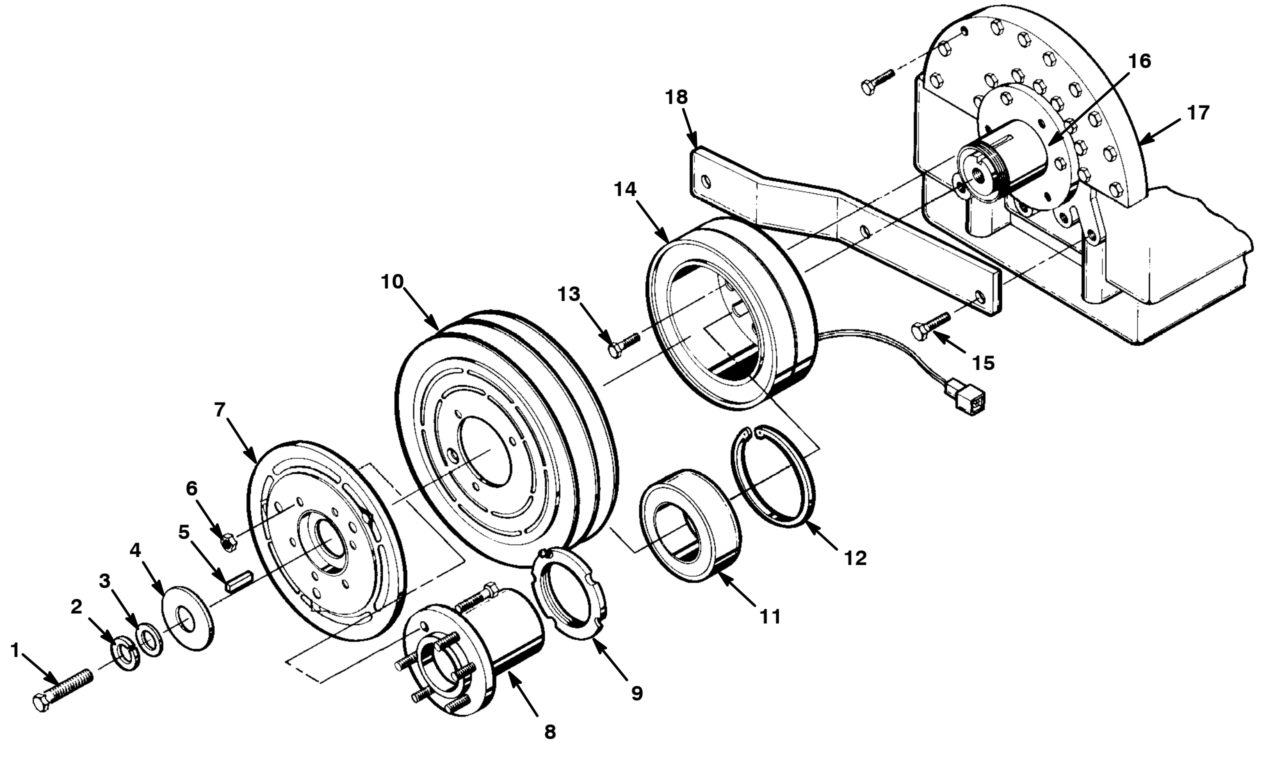


Figure 8. Coil-To-Rotor Clearance



1. CAPSCREW
2. LOCKWASHER
3. WASHER
4. WASHER
5. KEY
6. NUT
7. ARMATURE
8. ARMATURE HUB
9. LOCKING NUT (GREASABLE)
10. ROTOR (PULLEY)
11. BEARING
12. RETAINING RING
13. CAPSCREW
14. COIL
15. CAPSCREW
16. COMPRESSOR HALF FLANGE
17. BEARING MOUNTING HUB
18. BELT TIGHTENING CYLINDER BRACKET

4220

Figure 9. Housing-Mounted Compressor Clutch

5. Take appropriate measures to prevent the crankshaft from rotating and tighten the mounting capscrew to maximum 20 ft-lbs (27 N·m) torque.

⚠ CAUTION ⚠

Any bolts installed in the armature puller holes must have stop nuts in place to prevent insertion into the armature more than 3/8 inches (9.5 mm). This will prevent damage to the bearing seal, loss of bearing grease and clutch burn-out.

6. Replace compressor drive belts and close the manual valve to charge the belt tensioning air cylinder.

Clutch Lubrication (Housing Mounted)

The housing-mounted compressor clutch requires bearing lubrication periodically after the initial 5,000 miles (8,000 km) (Figure 9). The frequency of lubrication is once per year, or when the air conditioning system is being checked for operation. The point of lubrication is the grease fitting on the bearing retaining nut. Perform the following procedure to grease the bearing:

1. Open the two-way manual valve to vent air pressure from the drive belt tension air cylinder.

2. Remove the two A/C drive belts from the compressor clutch rotor.

3. Disconnect the coil electrical connector.

4. Insert tool 20-296 into two of the three threaded holes in the armature (Figure 10). This is to prevent the armature from rotating.

5. Remove retaining capscrew, lockwasher and flatwasher from compressor crankshaft.

6. Install a ⅞-14 x 2 inch (51 mm) capscrew into the center hole of the armature. Use this capscrew as a jacking bolt to draw the armature from the compressor crankshaft (Figure 11). Secure armature with tool 20-296, as in step 4.

7. Remove the armature (Figure 12).

⚠ CAUTION ⚠

Do not use a puller or pry bar against the armature or the end plate. To do so will cause damage to the armature assembly.

The requirement to remove the armature in order to grease the clutch bearing is to provide a means to clean excess grease from the clutch faces. This reduces the potential for clutch slippage, damage, and reduced torque transmission to the compressor. Modification of the clutch or the procedure to grease the bearing is unauthorized and will void the warranty covering the clutch and compressor.

8. Wipe the grease fitting clean of all dirt and foreign material.

9. Using a manual grease gun with an approximate 0.1 oz. (2.835 g) delivery per stroke, insert 1 ounce of grease into bearing. Grease must be Chevron SR1-2.

⚠ CAUTION ⚠

Do not give extra grease to the bearing "for good measure." Excess greasing will cause clutch slippage, overheated clutch parts and clutch failure.

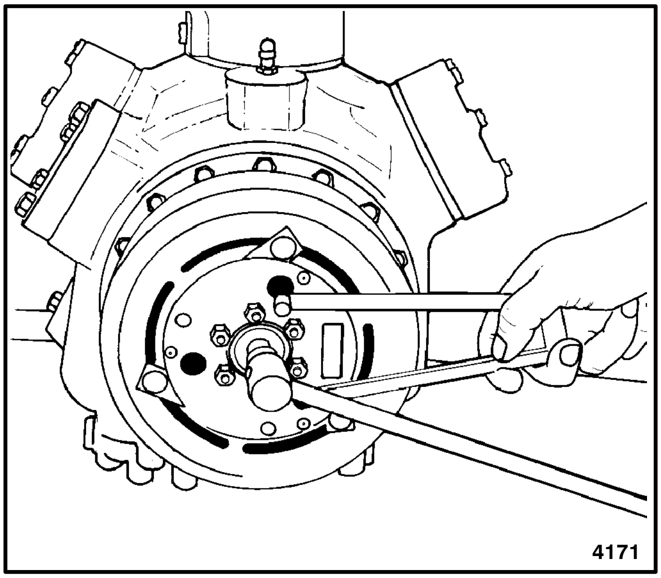


Figure 10. Capscrew Removal

10. Wipe all grease spills from clutch faces, retaining nut, hubs and washers. Use a clean cloth dampened in decreasing agent Trichloroethylene to clean clutch faces.

11. Install armature, flatwasher, lockwasher and armature retaining capscrew on compressor crankshaft. Tighten capscrews to 16-20 ft-lbs (22-27 N·m) torque.

12. Connect coil electrical lead, install drive belts and close two-way manual air valve.

Every 50,000 miles (80,000 km) clutch face wear should be measured according to the following procedure:

CAUTION

Clutch coil must be de-energized. If this procedure is done with the clutch mounted to the compressor while installed in the coach, ensure the engine starter cannot be engaged.

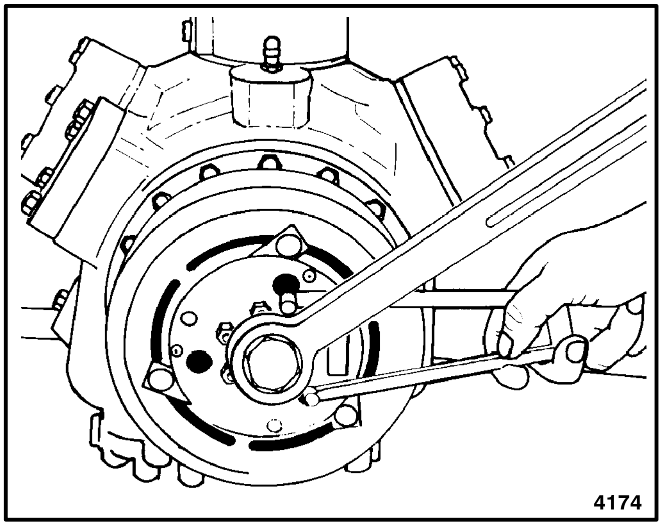


Figure 11. Armature Removal with Jacking Bolt

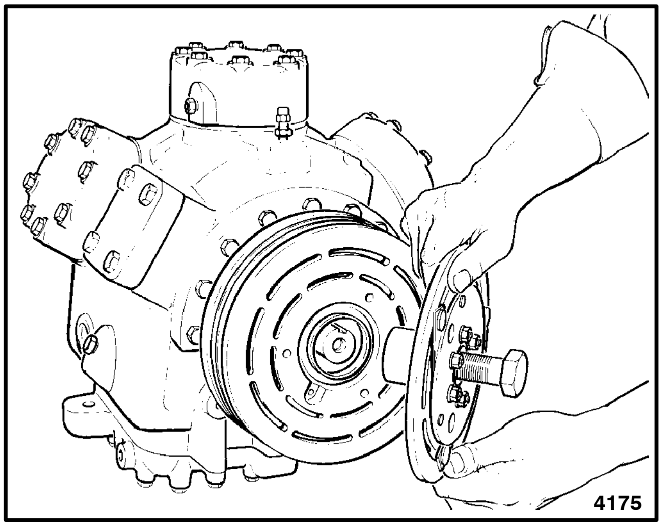


Figure 12. Armature Removal

13. Using a depth micrometer, measure and record the distance from the back of the armature to the face of the rotor (air gap) (Figure 7).

14. Disconnect the clutch coil electrical connector. Ground one connector terminal and connect 24 VDC to the other terminal to energize the clutch coil.

15. Repeat step 13 for the measured distance when the armature and rotor faces are engaged.

16. Determine the difference between the two measurements. If the difference exceeds 0.11 inch (2.794 mm), the clutch rotor and armature require replacement. Proceed to Removal and Disassembly, below.

CAUTION

Do not attempt to restore proper air gap by inserting or removing shims. Clutch failure and air conditioning compressor damage may result. After initial air gap adjustment when clutch is installed, shim pack should not be changed.

Bearing failure is usually associated with loss of lubricant from within the bearing. The lubricant may be deposited on the clutch faces and cause slippage. In cases where such slippage is suspected, the coach air conditioning system should not be used until the clutch is repaired, according to the following procedure.

Clutch Removal (Housing Mounted)

1. Follow steps 1 through 7 of the previous "Lubrication" procedure.

2. Using special tool number 20-294, remove the rotor retaining nut (Figure 13).

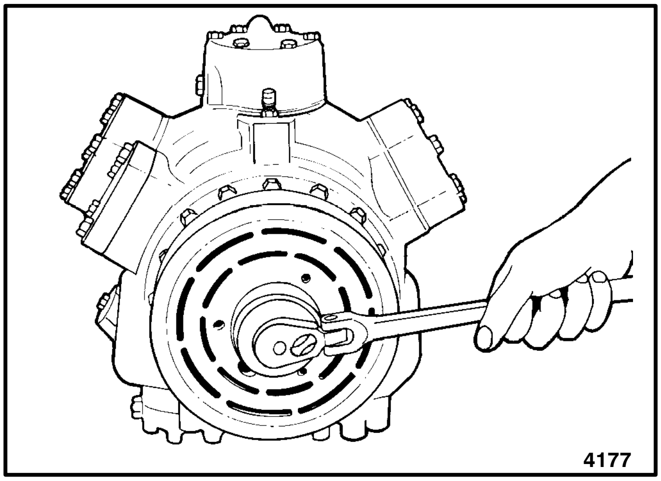


Figure 13. Removing Rotor Retaining Nut

NOTE: Two different bearing retaining nuts have been used by Carrier on the 05G compressor. One is a larger nut with a grease fitting; the other is smaller and does not have the grease fitting. Nearly all compressors installed have the large nut with the grease fitting and tool number 20-294 is used to remove and install that nut. However, if the compressor has the smaller nut, tool number 20-295 is required.

3. Install the gear puller into the three threaded holes of the clutch rotor (Figure 14).

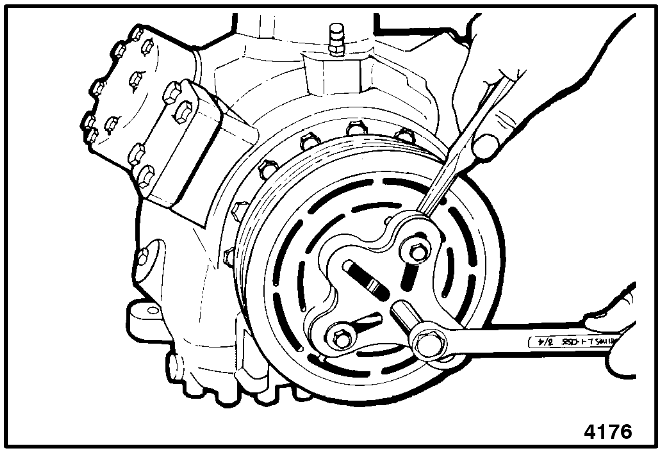


Figure 14. Removing Pulley

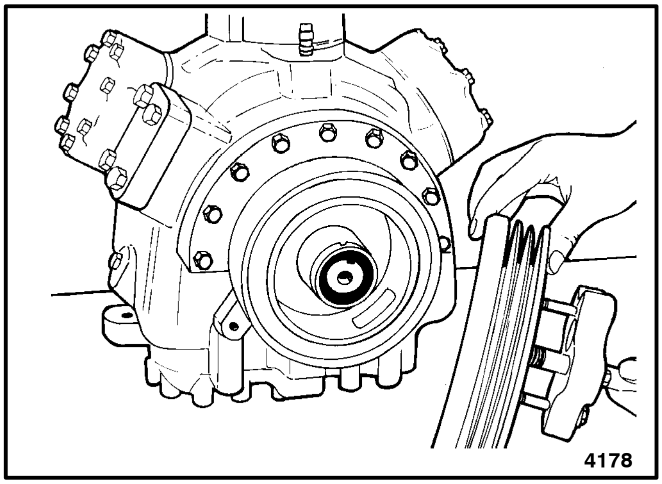


Figure 15. Pulley Removed

⚠ CAUTION ⚠

Use a washer, bushing or spacer to protect the end of the compressor crankshaft from being damaged by the gear puller. Do not use a puller mounted in the belt grooves of the rotor.

4. Rotate the puller bolt with a wrench and, while holding the rotor with a bar to prevent movement, draw the pulley from the bearing mounting hub (Figures 14 and 15).

5. Remove the three capscrews mounting the coil to the flange of the clutch bearing mounting hub. Remove the coil by pulling straight back.

⚠ CAUTION ⚠

Do not pry coil from mounting flange. To do so may bend coil mounting plate and cause misalignment of coil and rotor cavity.

If it is necessary to remove the bearing from the rotor, follow these steps:

1. Remove the retaining ring from the rotor bore (Figure 9).

2. Using the proper-sized arbor, press the bearing from the rotor.

Clutch Inspection (Housing Mounted)

1. Check the bearing for evidence of lubricant leakage, looseness or excessive free play from inner race to outer race. Check also for “roughness” in movement when inner and outer race are rotated in opposite directions. Replace the bearing if worn or defective.

NOTE: Bearing replacement is recommended any time the compressor clutch is serviced after 150,000 miles (240,000 km), regardless of its apparent condition.

2. Inspect the faces of both the rotor and armature assemblies. Surfaces should be clean and free of discoloration from grease or excessive heat. Check for presence of raised ribs on faces of rotor and armature. Replace both rotor and armature if raised ribs have been flattened or it the faces are contaminated or burned.

⚠ CAUTION ⚠

Both assemblies must be replaced as a pair. Do not intermix a used component with a new one. Premature clutch failure will result.

3. Inspect the coil for damaged electrical leads, bent or cracked mounting plate, or cracked coil potting compound. Electrical resistance between connector terminals of the coil should be 5.15-5.69 ohms. Resistance from either terminal to coil case (ground) should be infinite or open. Replace the coil if detective.

Clutch Installation

1. Position coil on clutch mounting hub with electrical leads at 4 o’clock position. Align the mounting holes.

2. Install the coil-mount capscrews and tighten to 25-30 ft-lbs (34-41 N·m) torque.

⚠ CAUTION ⚠

Do not draw coil onto flange with the capscrews. Distortion of the coil and misalignment will result.

3. If clutch bearing is not installed in rotor, do so using arbor and press. Install retaining ring.

4. To ease installation of the rotor onto the clutch bearing mounting hub (on compressor), preheat inner race of rotor bearing. A 75-100 watt outdoor post lamp-style bulb, placed in the bearing for 15-30 minutes, will heat the race.

⚠ CAUTION ⚠

Do not heat the bearing with own flame. Bearing must not be heated more than 175°F (79°C).

5. When bearing is heated, slide rotor assembly onto clutch bearing mounting hub. Use rotor installation tool 20-296 seated against the bearing inner race and tap lightly until bearing bottoms against flange (Figure 16).

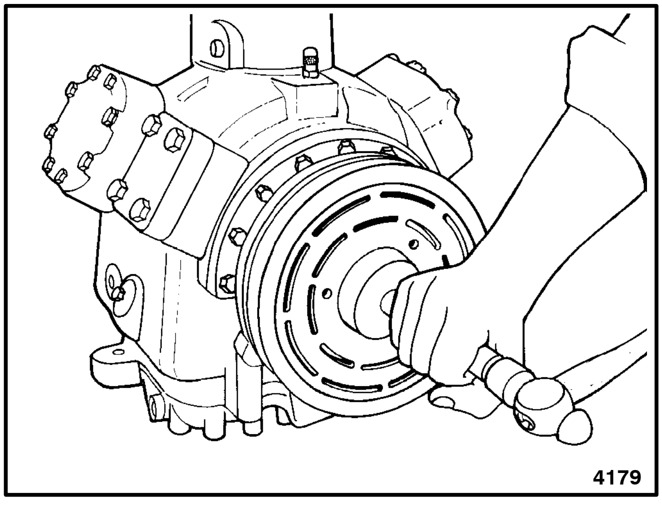


Figure 16. Installing Rotor/Bearing Assembly

6. Install bearing retaining nut, using tool 20-294 and a torque wrench (Figure 17). Due to the self-locking feature of the nut, observe the torque required to seat the bearing against the hub. After the bearing seats, tighten the nut 50 ft-lbs (68 N·m) greater than the bearing-seating torque.

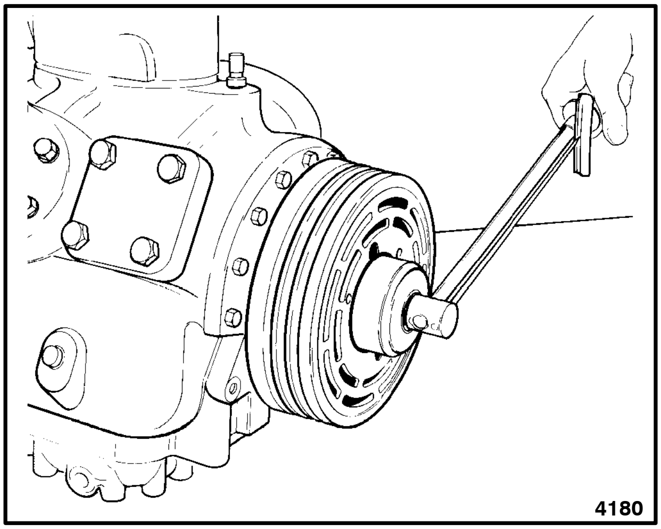


Figure 17. Tightening Bearing Retaining Nut

7. Check coil-to-rotor clearance with feeler gauge 0.02 inch (0.508 mm) thick by 0.156 inch (0.842 mm) wide (max.) (Figure 18). Insert the gauge through slot in the rotor face so it extends beyond the rear of the rotor. Slowly rotate the rotor one full revolution. The feeler should not rub or bind against the coil shell. Make the test through several evenly spaced slots around the rotor circumference.

NOTE: If the feeler gauge check shows misalignment between the rotor and field shell, determine the cause. The field mounting bracket must be flat and not distorted.

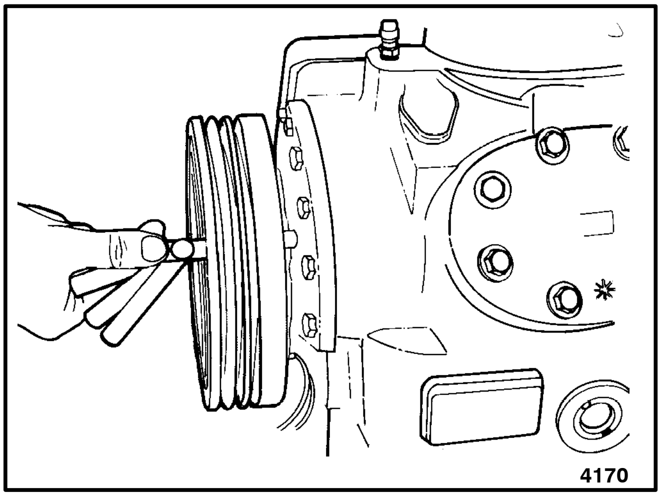


Figure 18. Checking Coil-to-Rotor Clearance

8. Place the armature and hub assembly onto the compressor crankshaft. Align the keyway slots in the crankshaft and armature hub.

9. Install the key into the keyways. Make sure the outer end of the key is flush with the hub counterbore.

10. Install the flatwasher, lockwasher and capscrew to secure the armature to the shaft. Tighten the capscrew to 16-20 ft-lbs (22-27 N·m) while using tool 20-296 to prevent armature rotation.

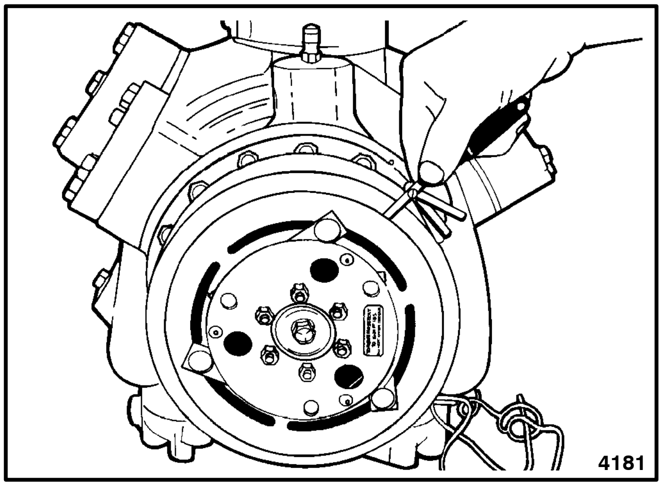


Figure 19. Rotor-to-Armature Clearance

NOTE: The remainder of this procedure applies to new clutch installations only.

11. Using a feeler gauge, measure and record the air gap between the rotor face and the armature face (Figure 19).

12. Determine if the air gap as measured meets the required air gap of 0.045±0.015 inch (1.143±0.381 mm).

NOTE: Shims have been factory installed between the armature and the armature hub. There are six 0.02 shims and one 0.01 shim; one or more of which may require removal in order to achieve the proper air gap for new clutch installations.

13. Determine which shims should be removed, if any, for the 0.045±0.015 inch (1.524±0.381 mm) air gap.

NOTE: The remainder of this procedure is necessary only if air gap is not within 0.03-0.06 inch (0.762-1.524 mm).

14. Install tool 20-296 to prevent armature rotation and remove the six armature-to-hub retaining nuts and washers (Figure 20).

15. Remove the armature plate and the required shims for the correct air gap.

16. Insert a 0.02 inch (0.508 mm) feeler gauge between the outside edge of the clutch bearing mounting hub and the inside edge of the armature mounting hub (Figure 21). If the clearance is less than 0.02 inch (0.508 mm), clutch installation is not correct. Determine the reason for the clearance discrepancy and correct before proceeding.

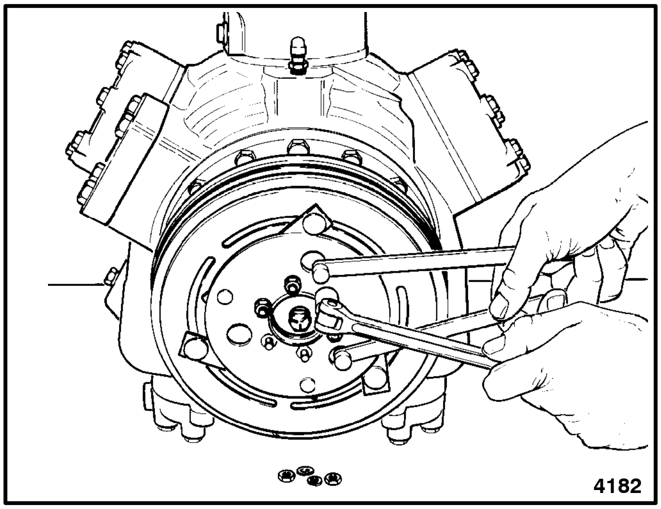


Figure 20. Removal of Armature Retaining Nuts

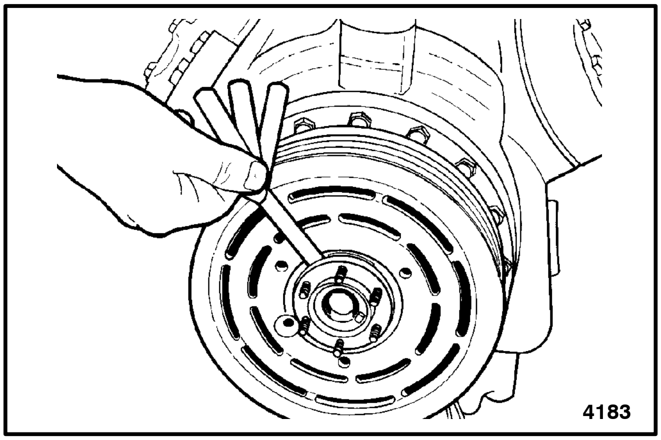


Figure 21. Bearing and Armature Hub Clearance

17. Reinstall the armature plate, washers and nuts. Tighten nuts to 7 ft-lbs (9.5 N·m) torque.

18. Check for the proper air gap between clutch faces. If satisfactory, procedure is complete.

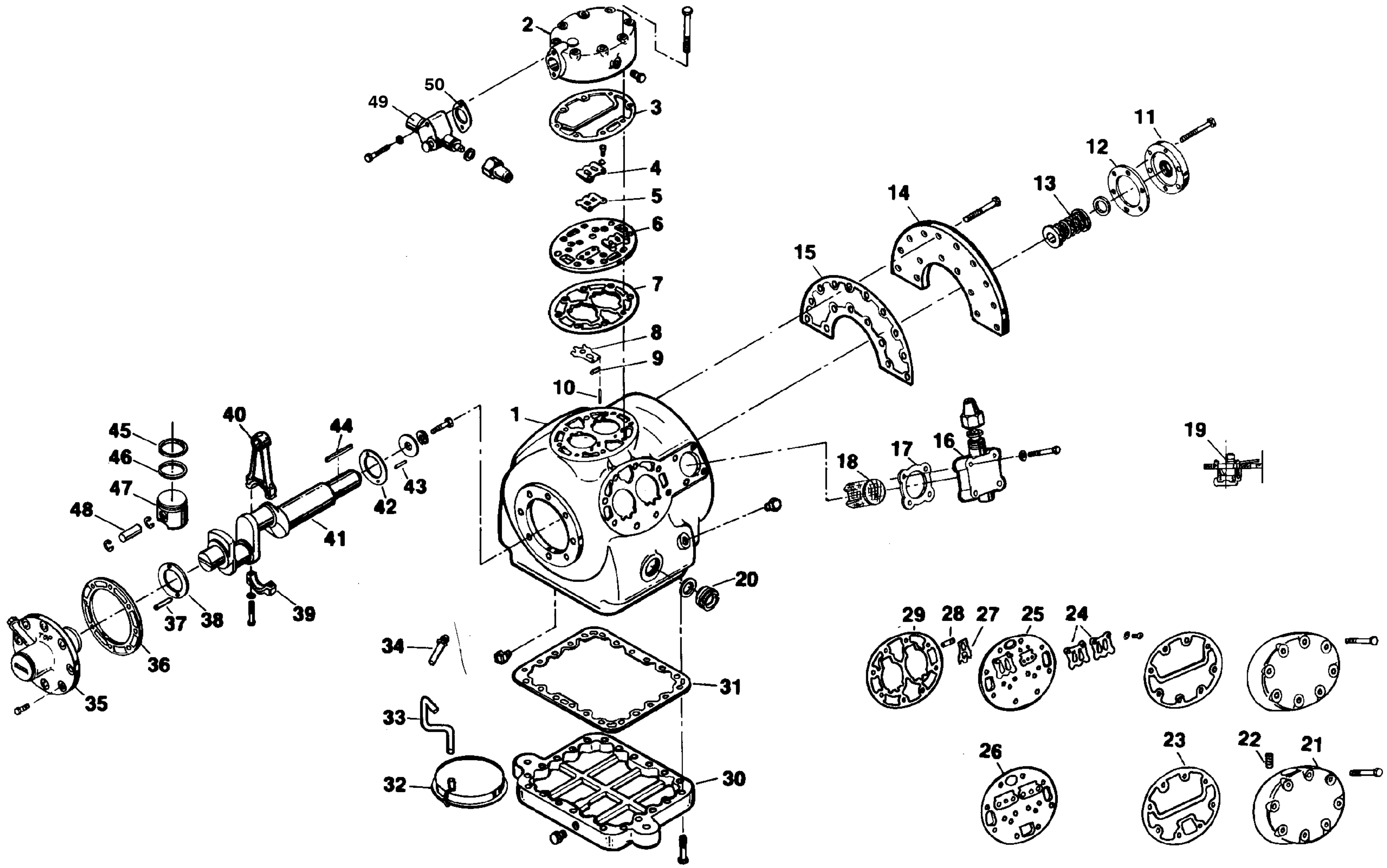
COMPRESSOR REMOVAL

1. Connect the service gauge manifold set.

2. If the compressor is inoperative, frontseat the suction and discharge service valves to trap the refrigerant, and isolate compressor.

NOTE: If the compressor will operate, frontseat the suction service valve and run the unit until a reading of slightly above zero is maintained; then, frontseat the suction and discharge service valves.

3. Evacuate the compressor and service hoses with refrigerant recovery unit.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1. Crankcase
2. Cylinder Head, Center Bank
3. Gasket
4. Stop, Discharge Valve
5. Discharge Valve
6. Valve Plate
7. Gasket
8. Suction Valve
9. Spring
10. Dowel
11. Seal Cover, Shaft
12. Gasket
13. Seal Assembly, Shaft
14. Flange
15. Gasket
16. Suction Valve
17. Gasket
18. Strainer
19. Unloader Check Valve
20. Sight Glass
21. Cylinder Head
22. Strainer
23. Gasket
24. Stop, Discharge Valve
25. Valve Plate
26. Valve Plate
27. Suction Valve
28. Spring
29. Gasket
30. Bottom Plate
31. Gasket
32. Oil Filter Screen Assembly
33. Oil Suction Tube
34. Oil Relief Valve
35. Oil Pump Assembly
36. Gasket
37. Pin
38. Thrust Washer
39. Rod End Cap
40. Connecting Rod
41. Crankshaft
42. Thrust Washer
43. Spirol Pin
44. Key
45. Ring, Compression
46. Ring, Oil
47. Piston
48. Pin, Piston
49. Discharge Shut-off Valve
50. Gasket

4167

Figure 22. Compressor Components

4. Disconnect electrical leads to compressor clutch and unloaders.

5. Unfasten and remove the compressor unloaders from the cylinder heads using the previous “Unloader Removal” procedure.

6. Loosen the compressor mount jack bolts, and remove the compressor drive belts.

7. Unfasten and remove the compressor mounting capscrews and remove the compressor from the coach.

CAUTION

The compressor weighs approximately 145 lbs. (65 kg). Exercise extreme caution during removal procedure. Use adequate sling and hoist.

COMPRESSOR DISASSEMBLY

Prior to disassembly of the compressor, oil must first be drained from the crankcase (Figure 22).

1. Remove the oil fill plug to vent the crankcase. Loosen the drain plug in the bottom plate and allow the oil to drain completely.

2. If dismantled parts are to be left overnight or longer, dip them in clean compressor oil and wrap them in oil soaked rags to prevent rusting.

NOTE: If a faulty part in the compressor is to be replaced, it may be necessary to remove other parts first. Therefore, the disassembly instructions that follow are arranged in the order for complete disassembly.

WARNING

Do not unscrew capscrews all the way before breaking seal. Entrapped pressure could result in injury.

3. Loosen cylinder head capscrews. If the head is stuck, tap it lightly with a wooden or lead mallet to free it.

4. Remove cylinder head. Be careful not to drop the head or damage the gasket sealing surface (Figure 23).

5. Remove cylinder head capscrews and gasket from the head.

6. Remove the discharge valve capscrews, lockwashers, stops, and valves (Figure 24).

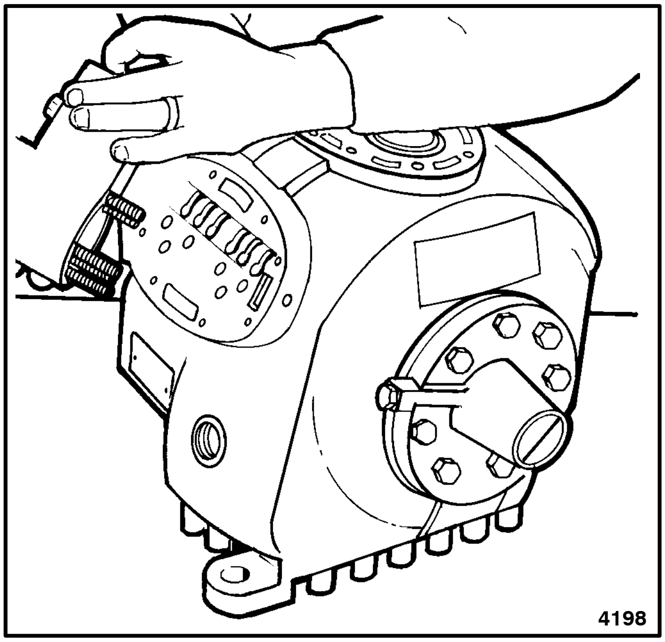


Figure 23. Removing Cylinder Head

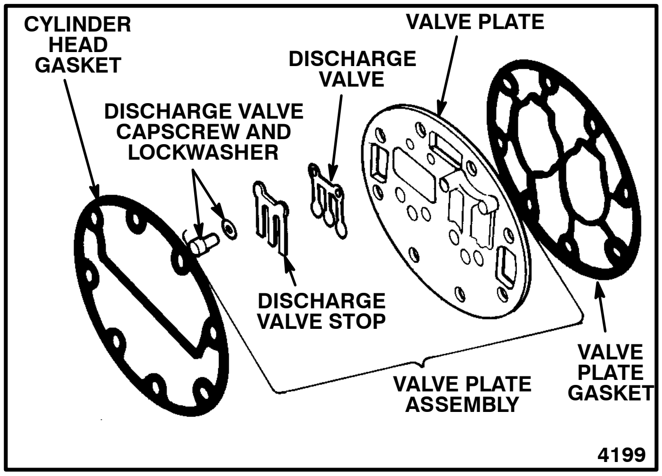


Figure 24. Discharge Valve Assembly

7. Free the valve plates from the cylinder deck by using the discharge valve capscrews, without washers, as jackscrews through the outermost tapped holes in the valve plate after the valve stops and valves have been removed. Remove the valve plate gasket (Figure 25).

8. Discard valves and gaskets. Use only new valves and gaskets when reassembling cylinder head and valve plate assemblies.

9. Loosen the capscrews that mount the suction and discharge service valves, and tap the valves with a hammer to free them from the mounting flanges. Remove capscrews and service valves, but do not remove hoses from valves.

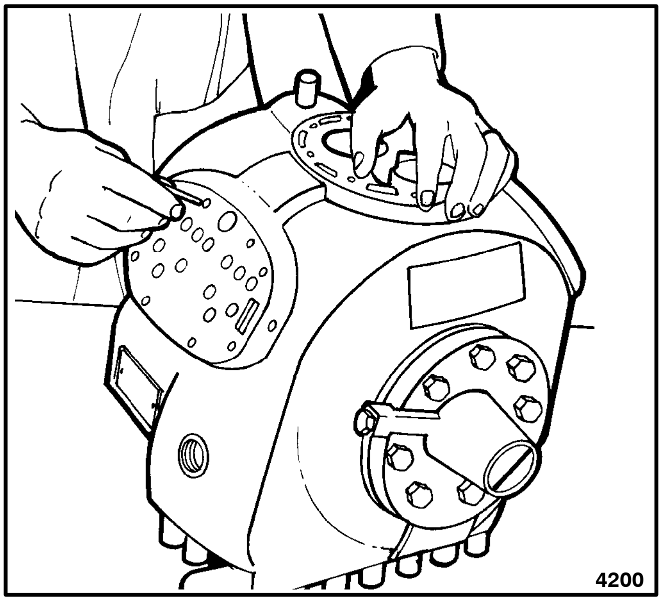


Figure 25. Valve Plate Removal

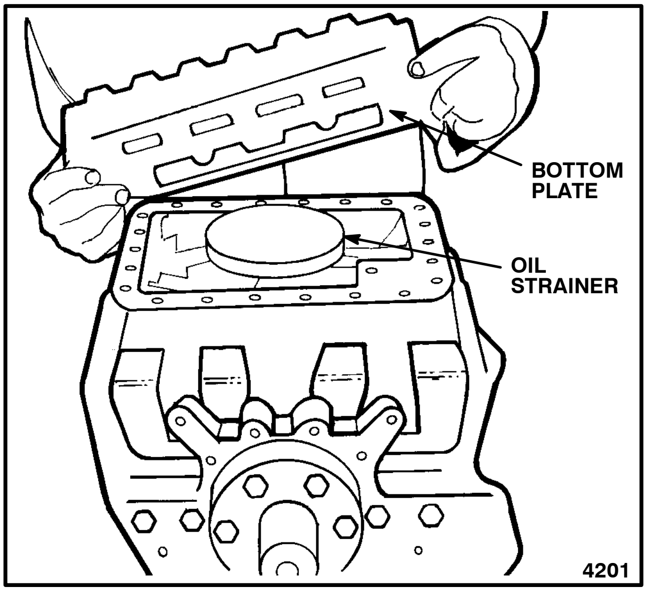

BOTTOM PLATE
OIL STRAINER
4201

Figure 26. Bottom Plate Removal

10. Remove the oil strainer.

NOTE: The capscrews and flat washers should be discarded and new epoxy encapsulated capscrews and flat washers installed during compressor reassembly.

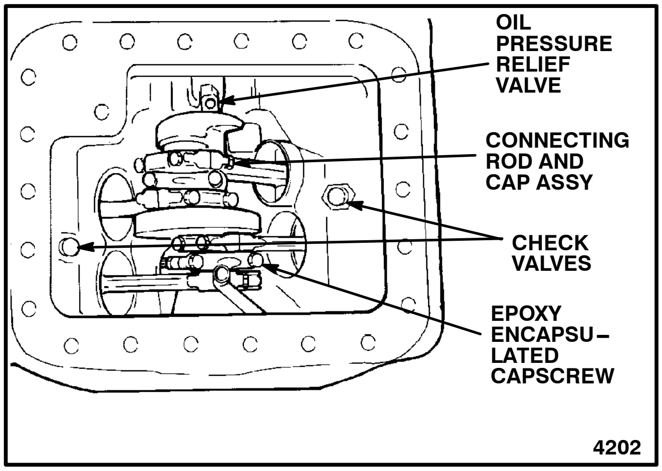

OIL PRESSURE RELIEF VALVE
CONNECTING ROD AND CAP ASSY
CHECK VALVES
EPOXY ENCAPSU–LATED CAPSCREW
4202

Figure 27. Compressor Crankcase Parts

11. Matchmark each connecting rod cap and connecting rod for correct reassembly.

12. Remove the capscrews, flatwashers and connecting rod caps (Figure 27).

13. Push the piston rods down so that the piston rings extend below the cylinders (Figure 28). Remove and discard piston rings.

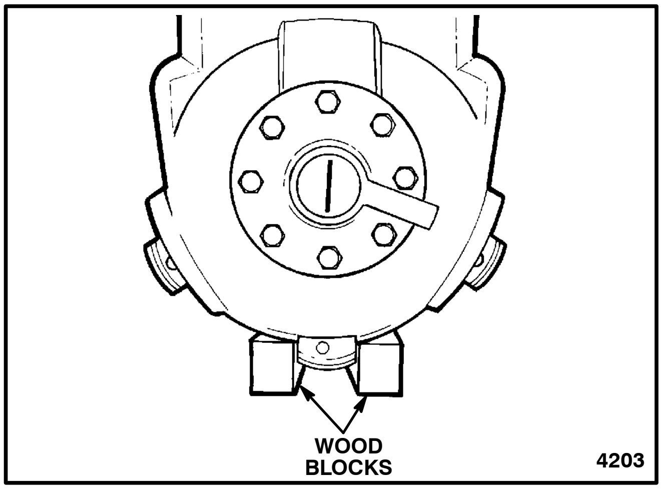

WOOD BLOCKS
4203

Figure 28. Piston Ring Removal

14. Remove eight capscrews and remove oil pump bearing head assembly, gasket and thrust washer (Figure 29). Disassembly and cleaning of the pump and bearing head assembly will be accomplished during inspection and before reassembly.

15. Remove six capscrews and remove shaft seal cover and carbon washer (Figure 30).

16. Tap seal end of crankshaft to loosen seal grip on shaft. Using two long screwdrivers, pry out the shaft seal (Figure 31).

⚠ CAUTION ⚠

Do not allow crankshaft to drop on connecting rods inside the crankcase when removing the crankshaft.

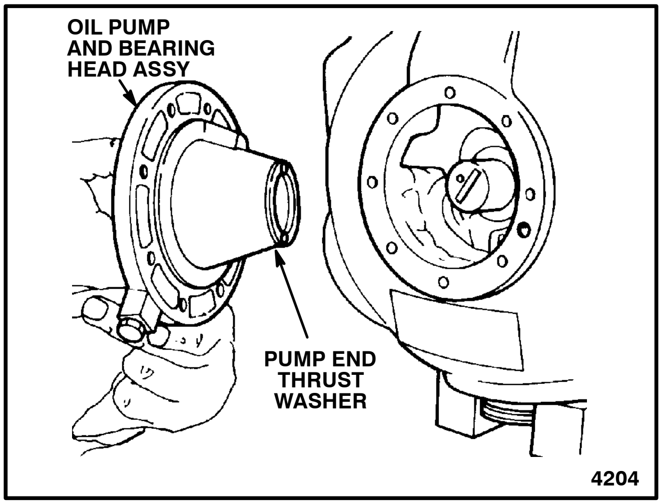


Figure 29. Removing Oil Pump

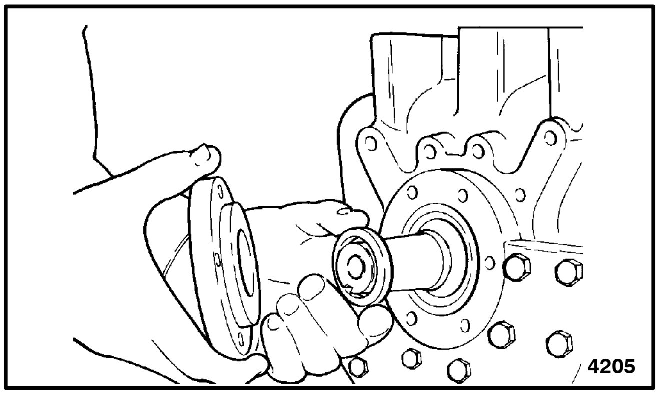


Figure 30. Seal Cover and Washer

17. Push piston rod assemblies out of the way and remove the crankshaft and seal end thrust washer.

18. Remove and check operation of the oil return check valves. The check valves are free-floating and can easily be checked visually.

19. Remove and check oil pressure relief valve. The oil pressure relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

20. Remove the piston rod assemblies.

21. Remove the suction strainer. Clean the strainer screen with solvent. Inspect the strainer; if damaged, replace it.

Oil Pump and Bearing Head

If it is determined that the oil pump is not operating properly, the entire oil pump and bearing head assembly must be replaced. Replacement parts for the pump are not available.

If the oil pump was operating properly, disassemble the pump, clean all parts, and reassemble the pump as follows (steps 1-11):

1. Remove pump cover and O-ring (Figure 32).
2. Remove pin by holding eccentric in, tipping top of pin slightly outward, and turning pump bottom side up; pin should fall out.
3. The remainder of the pump components can now be removed by pushing out the drive segment from the crankshaft end of the bearing head.
4. Remove the relief valve assembly by removing the retainer pin.
5. Clean all parts; coat all moving parts with compressor oil before proceeding with reassembly.
6. Insert drive segment and five-lobed rotor, ensuring that the pins on the rotor are inserted into the appropriate holes in the drive segment drive wheel.
7. Reinstall the four-lobed rotor inside the five-lobed rotor, ensuring that the end with the counterbore is installed toward the drive segment.
8. Reinstall the eccentric.
9. Reinstall the pin in the shortest of the two grooves inside the bearing head.
10. Reinstall the O-ring and pump cover.
11. Reinstall the relief valve assembly.

Pistons and Connecting Rods

Piston and pin, and connecting rod and rod cap are matched sets and must not be interchanged. If either the piston or piston pin is to be replaced, you must replace both of them. Likewise, if a connecting rod or rod cap must be replaced, both must be replaced.

1. Matchmark and disassemble pistons, pins, connecting rods, and caps.
2. Check wear dimensions of disassembled parts to determine if they are worn beyond limits as shown in figure 22. If parts are worn beyond limits, replace them in matched sets as specified above.
3. Coat piston pins with compressor oil and reassemble piston pins, and connecting rods in matched sets.

Inspection

1. Clean all parts with an approved solvent such as methyl ethyl ketone (MEK). Use a stiff bristle brush to remove dirt from grooves and crevices.
2. Inspect all parts for wear and overall condition. Replace any defective or excessively worn parts.

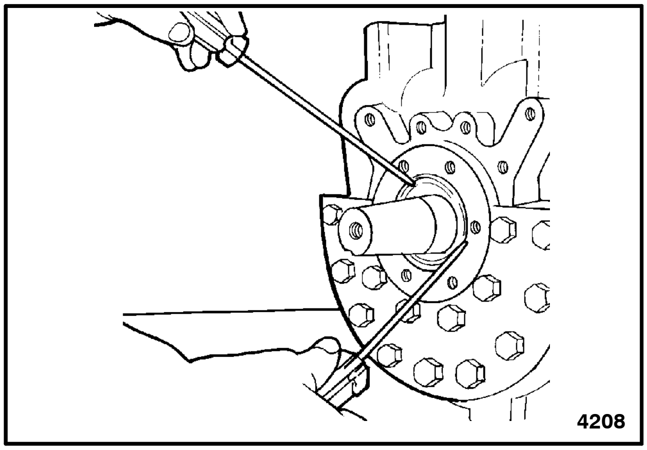


Figure 31. Shaft Seal Removal

3. Inspect suction and discharge valve seats on both sides of valve plate.

4. Inspect operation of unloader bypass piston.

5. Take inventory of all parts to ensure they are complete. After cleaning, coat all moving parts with compressor oil before reassembly.

6. Use only new gaskets during reassembly. Ensure all metal gaskets (includes cylinder head, valve plate, and unloader by bypass plug gaskets) are installed dry. All fiber gaskets should be finger wiped with compressor oil before installing.

COMPRESSOR REASSEMBLY

1. Prior to installing new piston rings, it is necessary to break the hard glazed surface of the cylinder in order to reduce the wearing-in period of the new rings. Break the glaze by rehoning lightly in an up-and-down rotating motion. Clean thoroughly after breaking glaze.

2. The gap between the ends of the piston rings can be checked with a feeler gauge by inserting the ring into the piston bore about one inch below the top of the bore. Align the ring in the bore by pushing it slightly with a piston. The maximum and minimum allowable ring gaps are 0.013 and 0.005 inches (0.33 and 0.127 mm).

3. Install the piston and rod assemblies up through the bottom of the crankcase and into the cylinders (Figure 33).

NOTE: Allow pistons to extend beyond the top of the cylinder to enable installation of piston rings. Pistons should be installed so that the chamfer on the connecting rod faces toward the crankshaft journals. Center rods on each crankshaft throw may be installed in either direction (Figure 34).

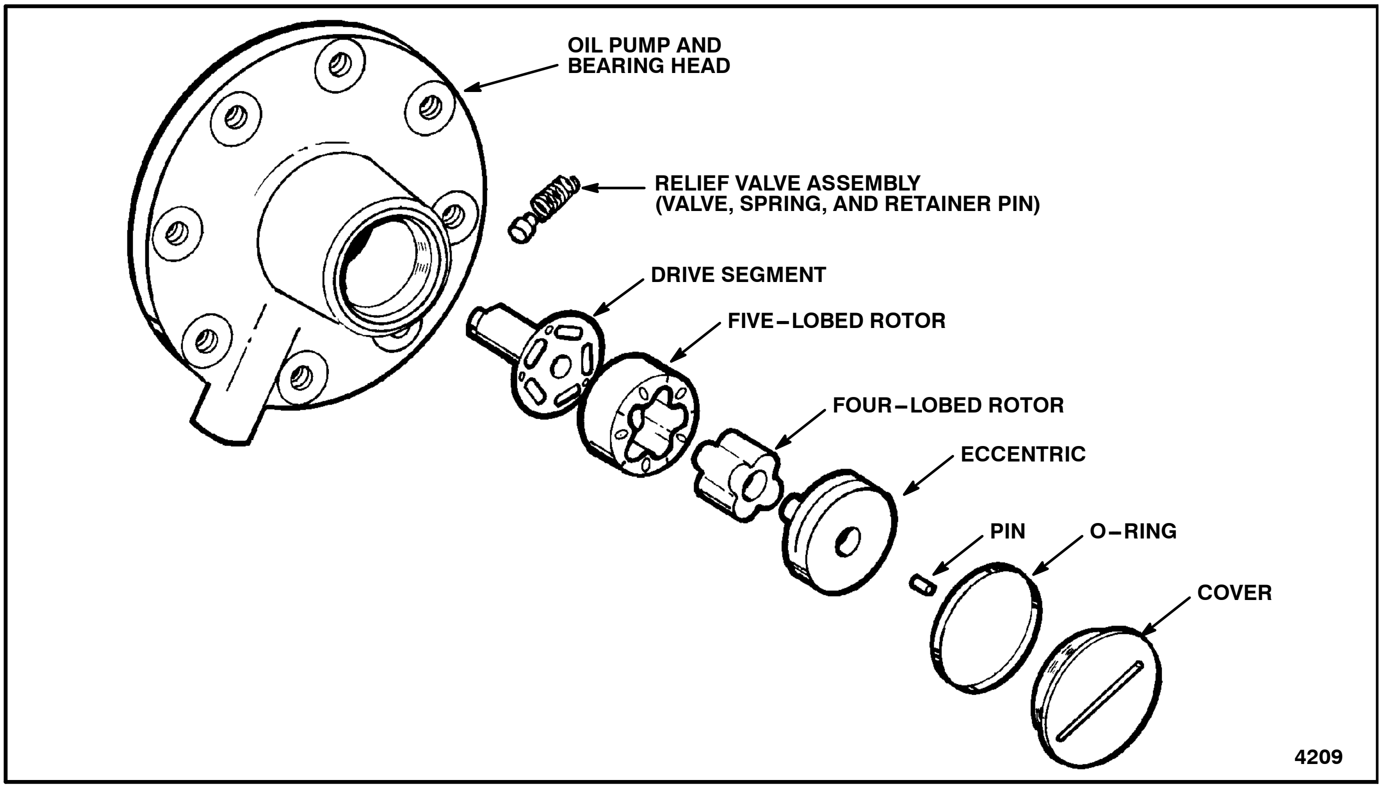

OIL PUMP AND BEARING HEAD
RELIEF VALVE ASSEMBLY (VALVE, SPRING, AND RETAINER PIN)
DRIVE SEGMENT
FIVE–LOBED ROTOR
FOUR–LOBED ROTOR
ECCENTRIC
PIN
O–RING
COVER
4209

Figure 32. Oil Pump Assembly

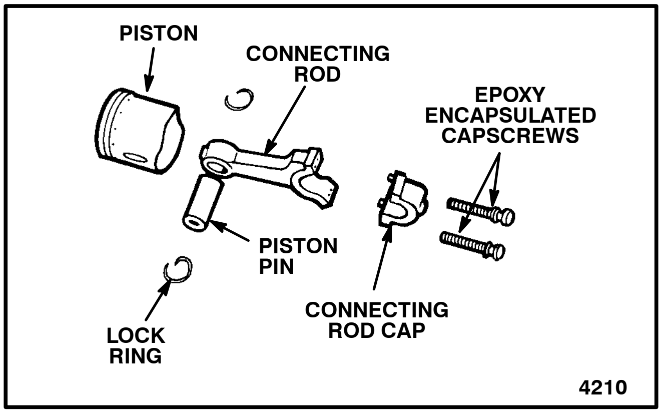

PISTON
CONNECTING ROD
EPOXY ENCAPSULATED CAPSCREWS
PISTON PIN
LOCK RING
CONNECTING ROD CAP
4210

Figure 33. Piston and Connecting Rod

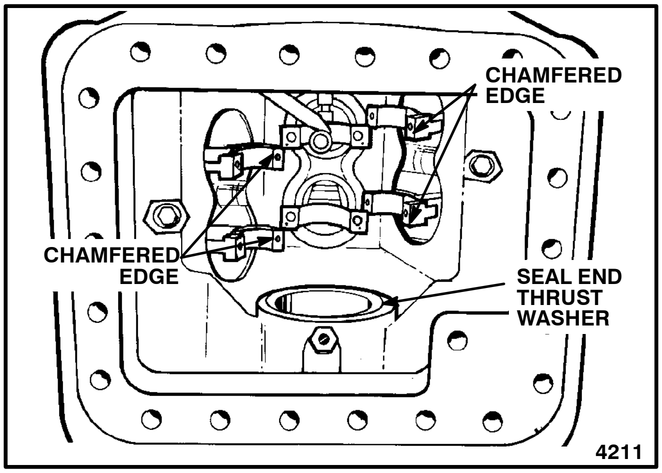

CHAMFERED EDGE
CHAMFERED EDGE
SEAL END THRUST WASHER
4211

Figure 34. Connecting Rod Placement

NOTE: Do not push pistons back into cylinder until after crankshaft is installed.

4. Install the oil and compressor piston rings onto each piston. Oil ring in the second groove first, and the compression ring in the first groove nearest the piston top.

NOTE: The oil ring is notched and must be installed with the notch on the outside circumference and on the bottom. The compression ring is tapered on the inside circumference (Figure 35). Install this ring with the taper on the top of the ring facing toward the valve plate.

When installing the rings, stagger the ring ends so that the gaps are not aligned. The ring grooves must be smooth so that the ring will not bind when compressed. Ensure that side clearance is 0.001 to 0.002 inch (0.0254 to 0.0508 mm) between the ring and the piston.

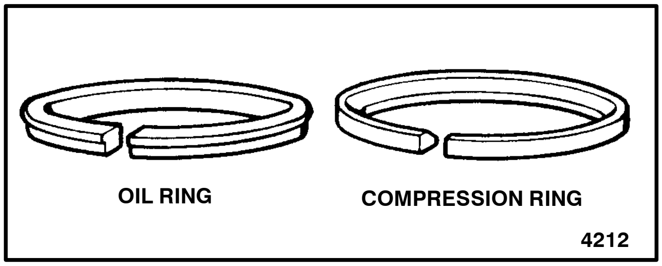

OIL RING
COMPRESSION RING
4212

Figure 35. Piston Rings

5. Inspect the two brass thrust washers and replace if worn or scored.

6. Install the seal end thrust washer on the two dowel pins in place in the crankcase (Figure 22).

⚠ CAUTION ⚠

Exercise care to make sure the crankshaft does not drop down onto the connecting rods when installing the crankshaft in the crankcase.

7. Push the pistons out of the way and install the crankshaft.

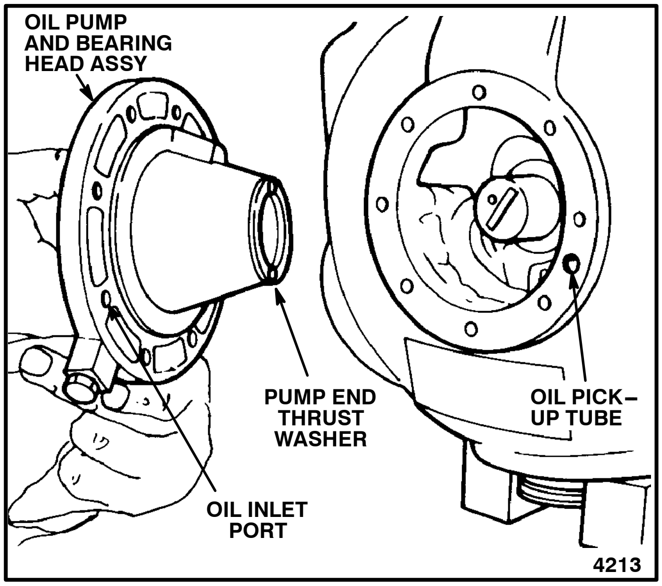

OIL PUMP AND BEARING HEAD ASSY
PUMP END THRUST WASHER
OIL PICK–UP TUBE
OIL INLET PORT
4213

Figure 36. Installing Oil Pump

8. Install the pump and thrust washer on the two dowel pins located on the bearing head (Figure 36).

⚠ CAUTION ⚠

Ensure that thrust washer does not fail off dowel pins while installing oil pump.

9. Install the bearing head assembly on the compressor crankshaft with a new gasket. Carefully

push oil pump on by hand ensuring that the thrust washer remains on the dowel pins. The tang on the end of the drive segment engages the slot in the crankshaft, and the oil inlet port on the pump is aligned with the oil pickup tube in the crankcase. The pump should mount flush with the crankcase and should be oriented as shown in Figure 36.

10. Align the new oil pump gasket and install the eight capscrews in the mounting flange.

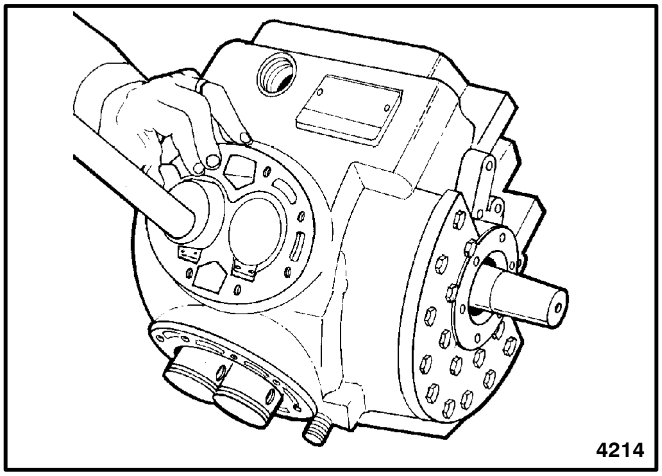


Figure 37. Tapping Piston Into Cylinder

11. Using a ring compressor, squeeze the rings sufficiently to allow piston to be pushed into the cylinder. Ensure that ring ends are staggered so that gaps are not aligned, and lightly tap piston down into the cylinder (Figure 37).

NOTE: The ring compressor can be easily fabricated from a piece of sheet metal.

12. Check matchmarks and install connecting rod caps on connecting rods using new epoxy encapsulated capscrews and flatwashers. Reuse of the old capscrews is not recommended. Ensure that the caps are installed on the dowel pins.

13. Tighten capscrews to 8-10 ft-lbs (10.8-13.5 N·m) torque. Ensure freedom of movement of crankshaft after capscrews are tightened on each rod cap.

14. Check operation and reinstall check valves and relief valve. The check valves are free-floating devices and can easily be checked visually. The relief valve is a spring-loaded device which can be checked by using a small piece of stiff wire to ensure that the spring mechanism can be depressed.

15. Clean and reinstall the oil strainer.

16. Using a new gasket, install the bottom cover plate. Tighten cover capscrews, in a diagonal pattern, to 25-30 ft-lbs (24-40.6 N·m) torque.

⚠ CAUTION ⚠

Never reinstall a used seal assembly or gasket. A new carbon washer should never be installed in a used cover plate. When installing the seal assembly, use care not to damage carbon washer or seal seat. If the new carbon washer is damaged during installation, replace it with a new one.

17. Remove new carbon washer from new seal assembly (Figure 38). Lubricate shaft and neoprene seal bellows where it contacts the shaft.

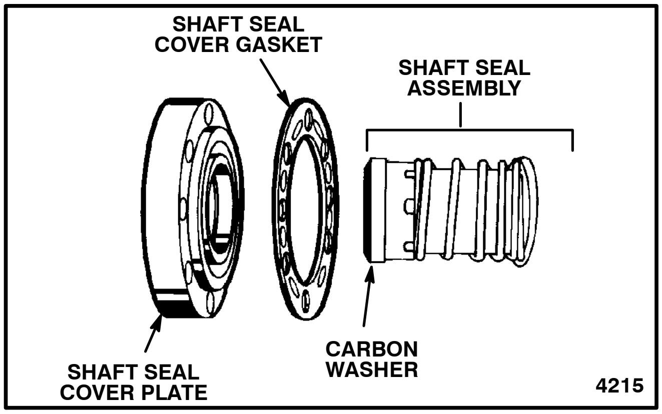


Figure 38. Shaft Seal Assembly

⚠ CAUTION ⚠

Handle carbon washer by touching only the outside edge.

18. Slide seal assembly onto shaft until neoprene bellows starts to grip the shaft (Figure 39).

19. Install the old carbon washer in the new seal seat. Install two capscrews in opposite sides of the old cover plate. Draw up capscrews evenly to properly position new seal assembly against shoulder on shaft.

20. Remove capscrews and old carbon washer and cover plate.

21. Lubricate new carbon washer and carbon washer seal seat with refrigerant oil. Install new carbon washer on the seat.

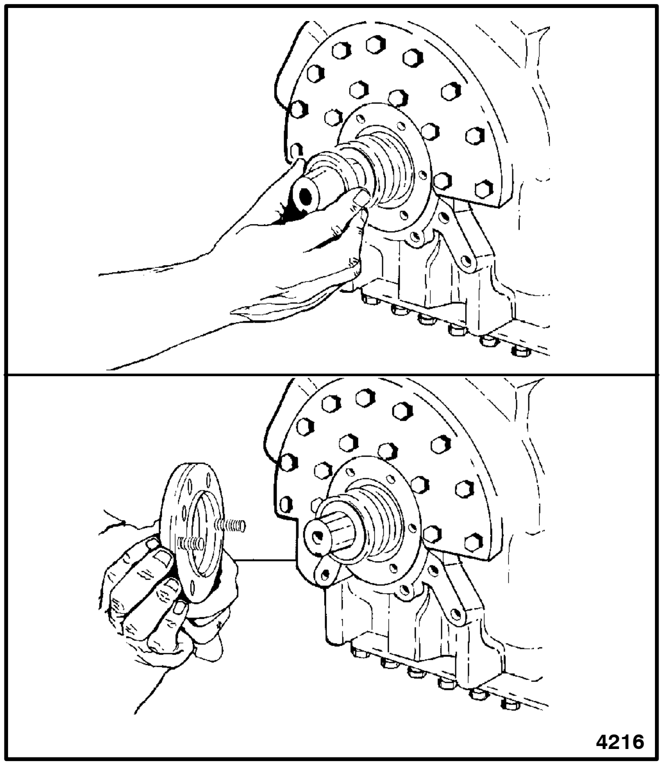


Figure 39. Installing Shaft Seal

NOTE: Ensure that notches in carbon washer are aligned with two small knurls inside the seal seat.

22. Install the new cover plate and gasket. Draw capscrews down evenly to prevent damage to carbon washer.

⚠ CAUTION ⚠

Install only new valves and gaskets, and do not interchange valves.

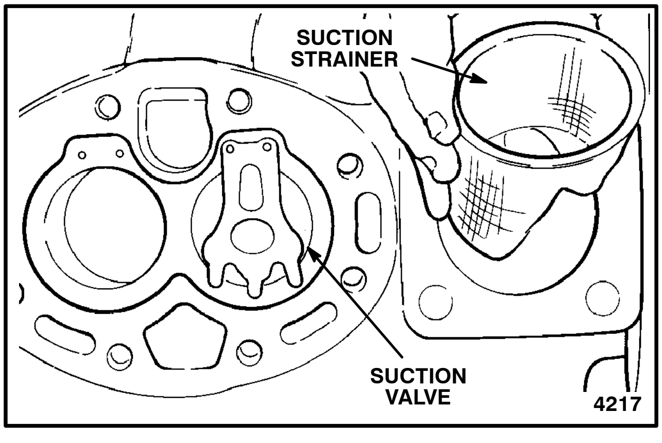


Figure 40. Suction Valve Installed

23. Install suction valve, positioning springs on dowel pins. Assemble positioning springs with spring end bearing against cylinder deck. The spring will bow outward in the middle (Figure 40).

24. Place suction valves on dowel pins, over the positioning springs.

25. Place valve plate and new valve plate gasket on cylinder deck, ensuring that the valve plate is properly positioned on the four dowel pins (top head has five dowel pins) (Figure 41).

26. Using a small screwdriver, flex the suction valves to ensure that the valve tips are not being held by the valve plate gasket (Figure 42).

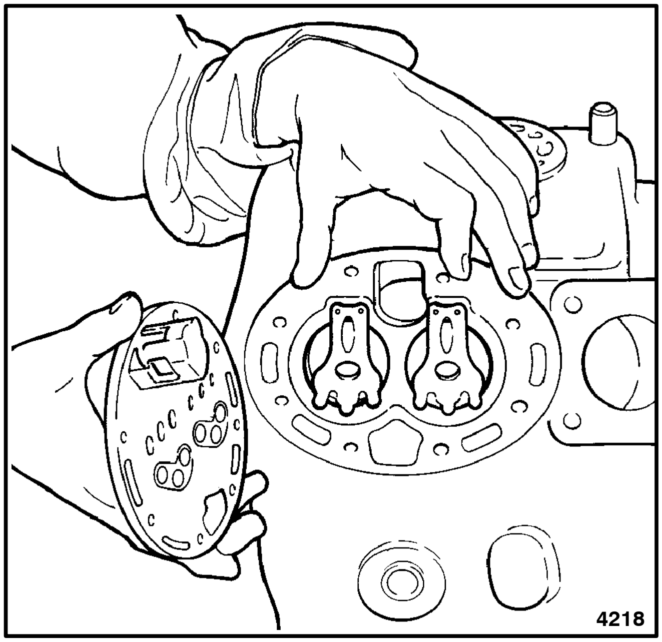


Figure 41. Installing Valve Plate and Gasket

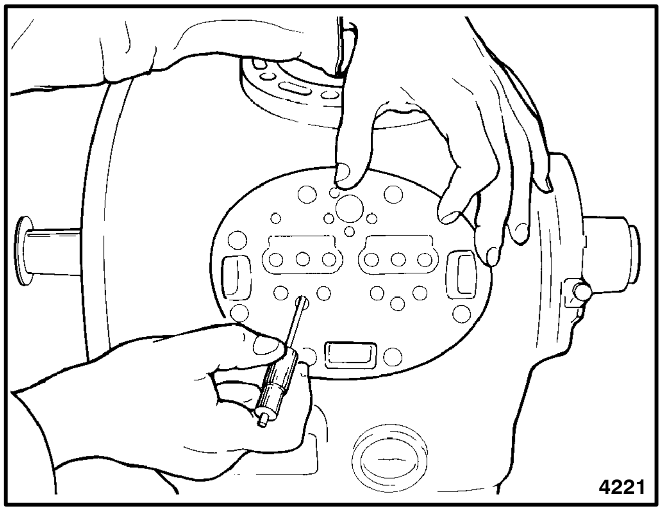


Figure 42. Flexing Suction Valve

27. Install discharge valve and discharge valve stop with capscrews and lockwashers (Figure 43). Tighten capscrews to 16-20 ft-lbs (21.7-27 N·m) torque.

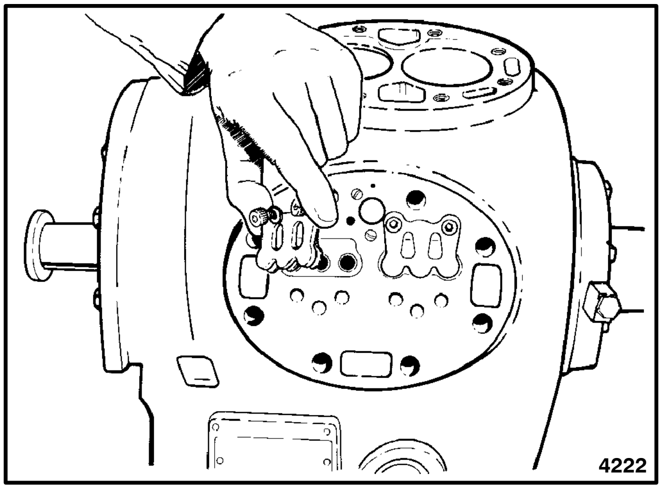


Figure 43. Installing Discharge Valve and Stop

NOTE: Capacity control unloaders are in place in the right and left cylinder heads. Refer to Capacity Control Unloaders, In this section, for instructions on their removal and installation if they are to be serviced.

28. The center tank has a flange connection for the discharge service valve. Install center cylinder head and new cylinder head gasket with capscrews, ensuring that the gasket and cylinder head are properly positioned on the valve plate.

29. Tighten the capscrews, in a diagonal pattern, 30-35 ft-lbs (40.6-47 N·m) torque. Repeat steps 23-29 for the other two cylinder banks.

NOTE: Suction strainer has been preformed to fit into suction cavity.

30. Remove and clean the suction strainer as shown in figure 40. Check for any damage, and if any is found, replace it. Reinstall the suction strainer and valve blank-off pad using a new gasket.

31. Install compressor according the following “Compressor Installation” procedure. Allow compressor to operate 4 to 5 hours before checking seal assembly for leakage.

COMPRESSOR INSTALLATION

Replacement compressors are normally furnished without suction and discharge service valves. The service valves are normally retained to isolate the refrigerant lines during compressor replacement. Blank-off pads are usually installed on the compressor service valve bosses. These pads must be removed prior to installing the compressor. If the faulty compressor is to be returned for overhaul or repair, install the pads on the compressor for sealing purposes during shipment.

⚠ CAUTION ⚠

Do not backseat (open) suction and discharge service valves until the compressor has been leak tested and evacuated.

1. Install the compressor in coach using the reverse removal procedure.

2. Install unloader by reverse removal procedure, and torque capscrews to 12-16 ft.lbs. (16-22 N•m).

NOTE: When installing new unloader gasket, align small crescent shaped cutouts with gas ports.

3. Install new locknuts on compressor mounting bolts and new gaskets on suction and discharge service valves.

4. Check oil level in oil level sight glass. Oil level should be between bottom and of sight glass. If necessary, add or remove oil.

5. Reinstall any pressure switches removed during the removal procedure. Reconnect electric unloader harnesses.

6. Leak test and evacuate the compressor.

7. Check refrigerant level before operating compressor

8. Fully backseat suction and discharge service valves.

9. Operate the compressor and check operation of capacity control unloaders.

MISCELLANEOUS TORQUE SPECIFICATIONS

SIZE DIA. (IN.)	THREADS PER IN.	TORQUE RANGE		LOCATION
		FT.-LB.	Nm	
1/16	27 (pipe)	8-12	10-16	Pipe Plug - Crankshaft
1/4	20 (pipe)	20-25	27-34	Oil Return Check Valve - Crankcase
	20 (pipe)	20-25	27-34	Pipe Plug - Pressure Gauge Connection
	20	8-10	10-13	Connecting Rod Cap Screw
	28	12-16	16-32	Unloader Valve
	28	6-10	8-13	Oil Pump Drive Segment
No. 10	32	4-6	5-8	Oil Pump Drive Segment
5/16	18	16-20	22-27	Cover Plate-Pump End Bearing Head
				Suction Valve
				Discharge Valve
				Suction Valve Adaptor-Crankcase
3/8	16	25-30	34-41	Pump End Bearing Head
				Bottom Plate - Crankcase
				Compressor Foot
				Seal Cover
	16	30-35	41-48	Cylinder Head
7/16	14	55-60	75-81	End Cover - Crankcase
1-1/4	18 NEF	35-45	47-61	Oil Level Sight Glass

COMPONENT WEAR LIMITS

PART NAME	FACTORY MAXIMUM		FACTORY MINIMUM		MAXIMUM WEAR BEFORE REPAIR	
	INCHES	MM	INCHES	MM	INCHES	MM
SEAL END						
Main Bearing Diameter	1.8760	47.6504			.002	0.051
Main Bearing Journal Diameter			1.8725	47.5615	.002	0.051
PUMP END						
Main Bearing Diameter	1.3755	34.9377			.002	0.051
Main Bearing Journal Diameter			1.3735	34.8869	.002	0.051
CONNECTING ROD DIAMETER	1.3755	34.9377			.002	0.051
Piston Pin Bearing			.6878	17.4701	.001	0.0254
CRANKPIN DIAMETER			1.9356	49.16	.0025	0.0635
Throw	1.9396	49.27				
THRUST WASHER (THICKNESS)						
Pump End	.145	3.683	.144	3.658	.040*	1.016
Seal End	.157	3.987	.155	3.937	.040*	1.016
CYLINDERS AND PISTONS	2.0005	50.8172			.002	0.051
Bore			1.996	50.0698	.002	0.051
Piston			.6873	17.4574	.001	0.025
Piston Pin Bearing			THUMBILT			
Piston Ring Gap	.013	.033	.005	0.127	.025	0.635
Piston Ring Side Clearance	.002	0.051	.001	0.0254	.002	0.051
SUCTION VALVE RECESSED (Depth)	.082	2.08	.078	1.98	.090	2.286

*** MAXIMUM END CLEARANCE BETWEEN THRUST WASHER AND SHAFT**

SPECIFICATIONS

COMPRESSOR

Manufacturer	Carrier Transicold
Part Number (R-22)	16J-2-22
Part Number (R-134A)	16L-2-40
Model	05G
Number of Cylinders	6
Operating Speed	400 to 2000 rpm
Bore	2 inches (50.8 mm)
Stroke	1!%P16 inches (49.2 mm)
Horsepower	25 (nominal)
Oil Pressure @ 1750 rpm	15 to 30 psi (103.5-207 kPa)
Oil Change	9 pints (4.03 liters)
Weight	145 lb. (64.5 kg)

APPROVED COMPRESSOR OILS

Type	R-22
DuPont	Zephron 150
Sunoco	Sunisco 3GS
Texico	WF1 132 WF68
Type	R-134A
Castrol	SW-68 (Icematic)

APPROVED CLUTCH GREASE

Chevron	SR1 or 2

REFRIGERANT CAPACITY

Type	R-22 or R-134A
Quantity	24 lbs. (10.8 kg)

CLUTCH

Type	Housing Mounted

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IN THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.

20-294	Socket for 05G A/C Compressor Clutch Bearing Retaining Nut with Grease Fitting (Large)
20-295	Socket for 05G Compressor Clutch Bearing Retaining Nut without Grease Fitting (Small)
20-296	Spanner Wrench for O5G A/C Compressor Clutch Armature Removal/Installation
20-297	Rotor Installation Tool

SECTION 16D

AUXILIARY HEATER (SERIES 60)

CONTENTS OF THIS SECTION

SUBJECT	PAGE
General Description	16D-1
Components	16D-2
Operation	16D-3
Maintenance	16D-4
Specifications	16D-5

GENERAL DESCRIPTION

Due to lower engine heat rejection temperatures the Webasto auxiliary heater is basic with all Series 60 diesel engine installations. The 80,000 btu/hr (maximum rated) diesel fired heater is used to augment the temperature of engine coolant for coach heating, and can be used as a coolant preheater before engine start-up. During operation the heater should keep coolant temperatures between 164°F and 182°F. The heater, along with the coach's normal HVAC controls, automatically maintains coach comfort levels. Additionally, the heater can provide on-demand heating (manual function), and may be pre-programmed for delayed operation (preheat mode) with either the digital or analog timer/control switch.

Note: The auxiliary heating function is activated anytime the coach "A/C/Heat" switch is positioned to heat.

The auxiliary heater is equipped with internal controls and a separate coolant circulation pump for operations in the preheat mode, cool down and purge cycle safety functions. To achieve both preheat and normal heating functions the heater's piping loop that connects to the coach heating system incorporates a bypass feature. Additionally, the heater's timer/control switch electrical circuits are wired directly to the battery and through the coach heating/cooling system control switch, with bypass valve circuit wired through the temperature controller.

The Webasto heater's coolant supply is piped directly off the engine oil cooler, and returns from either a heating or bypass circuit to the water pump. The unpressurized fuel supply for the heater is routed from the primary fuel filter head and returned to the air/fuel junction block. Exhaust from the heater is vented out the lower rear of the coach adjacent to the engine exhaust.

The heater timer/control switch is mounted on left hand dash knee pad under the left hand switch panel, and offers the normal automatic operation through the coach Heat/AC switch and thermostatic controller, unless specifically actuated for manual function. The preheat mode for the two timer/control switches is as follows: the analog timer/controller's programmable function offers a three day program period with a three hour heating cycle each day, while the digital timer/controller features a ten day program with three one hour heating periods.

Note: The analog timer/controller has a round body, while the digital timer/controller has a square body.

COMPONENTS

HEATER ASSEMBLY

The major component of the installation is the Webasto heater assembly (Figure 1). The heater is mounted on a support frame below the radiator compartment at the left side of the engine compartment. The heater assembly includes a combustion chamber/heat exchanger, temperature limiter, burnerhead and coolant pump.

The combustion chamber/heat exchanger area is where the coolant is heated. The normally closed temperature limiter switch and the overheat fuse are the combustion chamber safety devices. The burnerhead contains the fuel pump and motor, spray nozzle and electronic ignition assembly that produces the burner flame. The coolant pump and motor attaches to the heater and circulates coolant through the heat exchanger, and the bypass pipe during preheat function.

Note: The temperature limiter thermostatic switch should trip at 242°F and can be manually reset after coolant temperature drops.

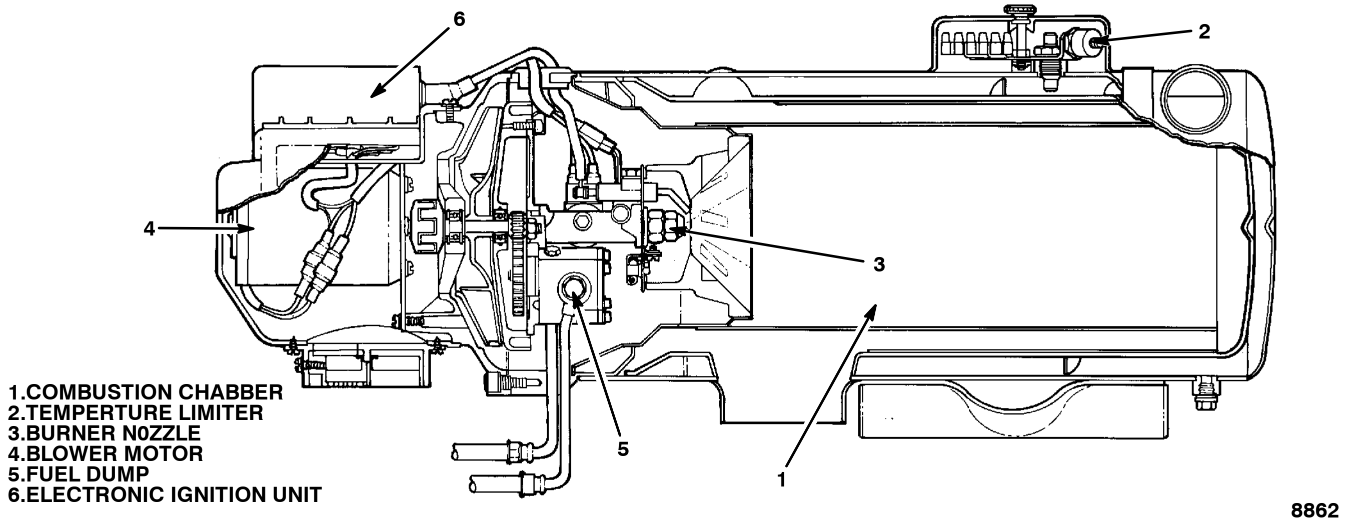

6
2
4
3
5
1
1.COMBUSTION CHABBER
2.TEMPERTURE LIMITER
3.BURNER N0ZZLE
4.BLOWER MOTOR
5.FUEL DUMP
6.ELECTRONIC IGNITION UNIT
8862

Figure 1. Auxiliary Heater

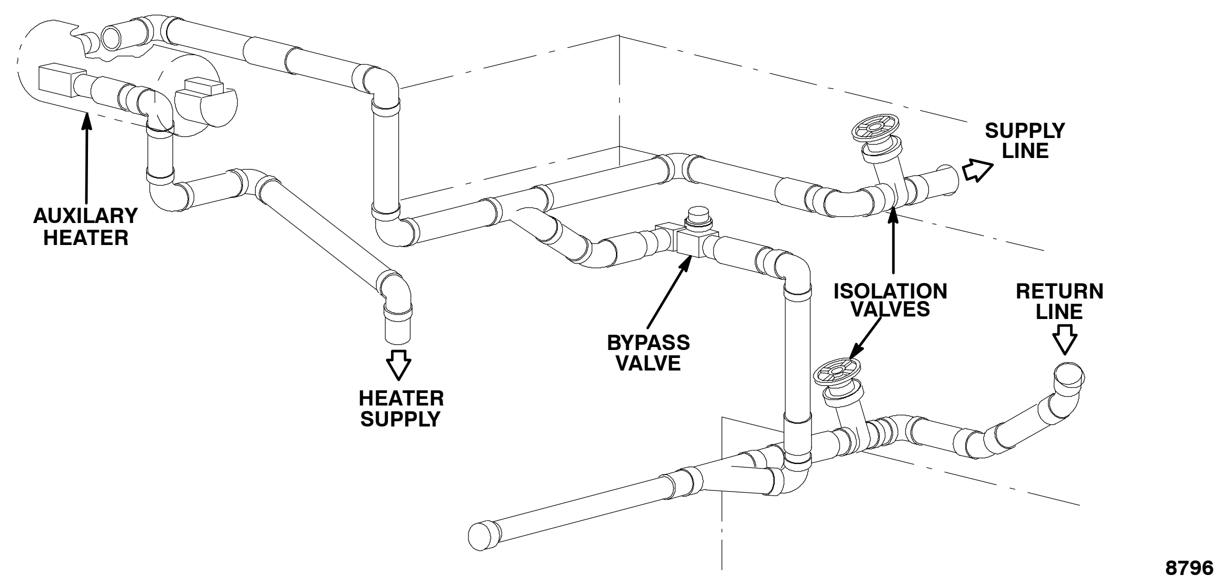

SUPPLY LINE
AUXILARY HEATER
ISOLATION VALVES
RETURN LINE
BYPASS VALVE
HEATER SUPPLY
8796

Figure 2. Auxiliary Heater Piping

BYPASS VALVE

The normally open bypass valve directs the flow of coolant through the coach heating system or through the engine bypass loop (Figure 2). The bypass valve is of the same design as the main heater coil water valve. The valve's electrical circuit is wired through a front junction box relay that works the valve in reverse of the main heater coil's water valve.

TIMER/CONTROL SWITCH (DIGITAL)

The auxiliary heater is controlled through the digital timer and control switch mounted in the left hand dash knee pad below the left hand switch panel (Figure 3). For preheat mode the digital timer/control switch allows the heater to be programmed for three independent start up times, up to ten days in advance.

Note: Preheat mode has a one hour of operating cycle.

Note: The display format of the digital timer utilizes 24 hour (military time).

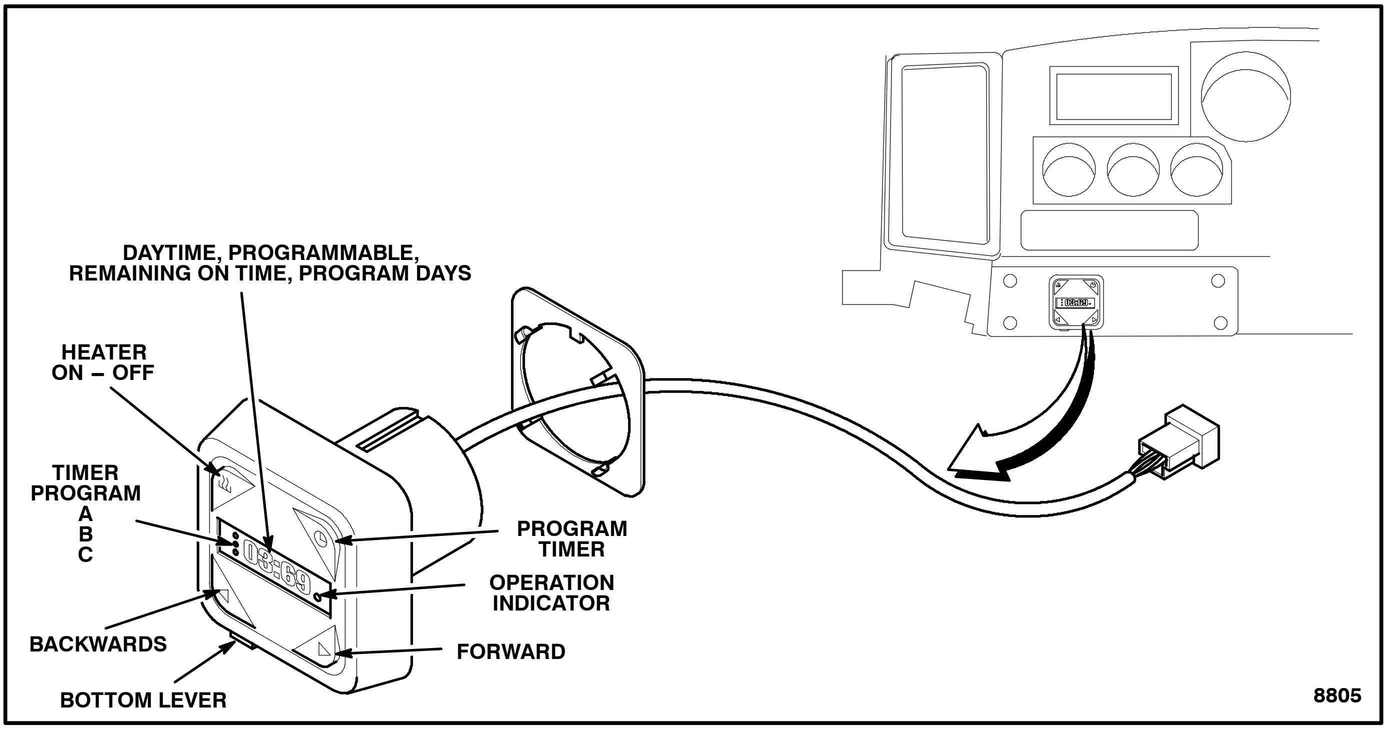


Figure 3. Dash Mounted Timer

TIMER/CONTROL SWITCH (ANALOG)

The analog timer controls the heater in much the same way as the digital timer, although, the operation of the timer differs from that of the digital timer while in preheat function. The analog timer/control switch allows the heater to be pre-set for three heating cycles within a three day period. The analog timer/control switch is mounted in the same location as the digital switch.

Note: Preheat mode has a three hour operating cycle.

Note: The clock dial display of the analog timer utilizes three 24-hour segments totaling 72 hours (military time).

OPERATION

AUTOMATIC FUNCTION (NORMAL)

When heat is required in the passenger or driver's compartment the Heat/AC switch is positioned to "Heat". This energizes the auxiliary heater relay and, if the coolant temperature is below 182°F, the digital timer/control switch's operation indicator light should light, signalling that the heater is operating. Heater function is now directed by the electronic controller (see "Functional Diagram" in the "Operating Instructions" booklet).

Although the heater may begin operations, no heated coolant will enter the coach's heating system coils until the coach's HVAC thermostatic control "heat-on" setting has been reached. Once the setting is attained, the controller's circuit powered through the master run switch, energizes the water valve relay, in turn opening the main heater water valve and closing the bypass water valve.

Note: Heat/AC switch circuit and temperature controller circuit are independent of each other.

Note: The timer/control switch should not be in preheat mode (flashing) for normal automatic operation of the heater.

The heater will continue to operate cycling on and off through the heater's internal controller, until the coach's temperature controller has reached the cut-off setting. When the coach controller reaches the "heat-off" temperature setting the main heater water valve closes and the bypass valve opens. The auxiliary heater should continue to operate as long as the engine coolant temperature remains below 182°F, or until driver repositions the Heat/AC switch to center "Off" position.

⚠ WARNING ⚠

Heater must be switched off during fueling operations.

MANUAL FUNCTION (ON-DEMAND)

Digital (Electronic)

On occasions when the auxiliary heater is needed for coach comfort (i.e. in-station heating) or instantly fired (i.e. testing), simply press the heater on/off selector switch, (upper left corner), and pull lever of the digital timer/control switch to start heater function. The heater will operate until the digital timer/control switch is pressed again.

Analog (Quartz)

To initiate heater operation with the analog timer/control switch, rotate outer ring until orange pointers bracket the white pointer and pull out on the switch's push/pull button, (center of dial). The heater will operate until the timer/control switch's button is pressed in.

Note: The timer/control switch's operation indicator light should light while heater is on.

PREHEAT FUNCTION (PROGRAMMED)

Digital (Electronic)

After presetting timer, select one of the three programs by pressing the program time selector switch, (upper right corner) indicated by the program light. The switches operation indicator light should flash (armed) until reaching programmed time, then show steady. The heater will automatically begin operation at the designated time after program selection has been made.

Analog (Quartz)

To initiate heater operation with the analog timer/control switch, rotate outer ring until orange pointers bracket the intended pre-set time period, and pull out on the switch's push/pull button, (center of dial). The switches operation indicator light should flash (armed) until reaching programmed time, then show steady. The heater will automatically begin operation at the designated time.

Note: See operating instruction for setting and programming digital/analog timer/control switches.

MAINTENANCE

PERIODIC MAINTENANCE (HEATER)

⚠ CAUTION ⚠

The service personnel responsible for maintaining the Webasto Heater should have a complete working knowledge of all heater systems and functions including control and safety devices.

A yearly maintenance, prior to the seasonal heating period, is required for the auxiliary heater. The following items should be checked and replaced to assure proper operation of the auxiliary heater system.

1. All external coolant, fuel, exhaust and electrical connections should be inspected for leakage, blocks and/or secure attachment.
2. Clean the exterior and interior of the heater, including the combustion chamber, flame detector and ignition electrodes.
3. After cleaning test run the heater to check all operations, including safety functions.

Note: The auxiliary heater should be started periodically during the off season to check operation.

⚠ CAUTION ⚠

Never operate heater in confined areas like a garage or workshop, unless equipped with an exhaust extraction system.

AUXILIARY HEATER REMOVAL

To remove the Webasto heater assembly from the engine compartment, follow this procedure in order.

1. Turn battery switch to “Off”.
2. Disconnect coach electrical harness at controller and circulation pump harness.
3. Disconnect heater’s fuel lines at supply/return tube stubs and plug.
4. Close the isolation valves of the heating circuit.
5. Loosen clamps and disconnect coolant outlet/bypass tube at heater outlet.
6. Loosen clamps and disconnect coolant supply tube at heater’s circulation pump inlet.
7. Unfasten circulation pump mounting straps and remove pump from heater.
8. Disconnect and remove the flexible section of exhaust pipe from heater’s combustion chamber outlet.
9. Unfasten and remove heater mounting bolts and slide heater toward engine while turning to remove from compartment.

AUXILIARY HEATER INSTALLATION

1. Reverse the heater removal procedure.
2. Run engine to circulate coolant into heater, before testing heater function.

BYPASS VALVE REMOVAL

1. Turn battery switch to “Off”.
2. Close the isolation valves of the heating circuit.
3. Disconnect hose clamps and remove hose from valve’s inlet/outlet nipples.

Note: It may be necessary to loosen outlet/bypass tube from heating circuit piping, or unfasten heater mounting bolts to remove valve.

4. Lower valve assembly, and disconnect air and electrical connections, then remove from engine compartment.

BYPASS VALVE INSTALLATION

1. Reverse removal procedure.

TIMER/CONTROL SWITCH REMOVAL

1. Turn battery switch to “Off”.
2. Disconnect wiring harness from rear of timer/control.
3. Disengage retainer plate from timer body and slide timer out.

TIMER/CONTROL SWITCH INSTALLATION

1. Reverse removal procedure.

Note: Make sure that retainer plate’s tab is orientated properly on timer body groove after inserting timer into cut-out.

SPECIFICATIONS

AUXILIARY HEATER ASSEMBLY

Manufacturer	Webasto
Part Number	16L-16-45
Part Number (Pump)	16L-16-185
Model	DBW 2020
Rating	80,000 BTU
Controller	Electronic
Operating Range	164_–182_F (73_–83_C)
Lubrication	(Aeroshell 7)Isoflex

DIGITAL TIMER/CONTROL SWITCH (ELECTRONIC)

Manufacturer	Webasto
Part Number (7 Day)	7L-8-1748
Type	(Military Time) 24-Hour Digital
Function	10 Day Programmable

BYPASS WATER VALVE

Manufacturer	Honeywell
Part Number	16L-7-100
Type	Electrically Piloted/Air Operated

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

SECTION 17

LAVATORY

SECTION 17

LAVATORY

SUBJECT PAGE
General Description 17-1
Components 17-1
Operation 17-4
Maintenance 17-4
Troubleshooting 17-10
Specifications 17-11

GENERAL DESCRIPTION

The coach may be equipped with the standard size lavatory or the optional extended lavatory installations. Lavatory facilities are installed at the right rear corner of the coach, and can be easily entered through the door located at the end of the asile. Installation of the lavatory eliminates seating for two passengers only, leaving a three person rear cross seat.

Extreme care has been taken in the design of the lavatory. The use of stainless steel in conjunction with melamine enables the lavatory to be easily maintained in a pleasing condition at all times. The lavatory features an embossed stainless steel floor with stainless steel brush finish sidewalls, stainless clad door and sink partition. Permanent finish melamine panels are utilized on the upper half of the washroom front and sidewalls for ease of cleaning and resistance to damage.

COMPONENTS

The lavatory comes complete with either a chemical or flush toilet and a wash basin. Other facilities include a towel dispenser, waste paper receptacle and soap dispenser. A large mirror is mounted on the back wall above the wash basin. Various other items associated with the lavatory are also described below (Figure 1).

CHEMICAL TANK

The lavatory's chemical or flush toilets utilize the same waste holding tank filled with a chemical charge. The chemical charge both deodorizes and naturalize solid waste. Both holding tanks features a vacuum ventilated drop tube assembly to help eliminate odors.

A manually operated slide dump valve is provided to drain the waste holding tank. The optional auxiliary waste retention tank can be fitted to provide additional capacity. This tank comes complete with an additional slide dump valve and connecting tube.

NOTE: Holding tanks may be fitted with an immersion heater to prevent freezing.

FLUSH PUMP

The flush toilet's air-operated diaphragm pump is a self-contained flushing unit contained within the flush unit and mounted to the bottom of the chemical tank. The flush tank continually recirculates the chemically charged waste water during the self-clean flush cycle.

FRESH WATER STORAGE TANK

A stainless steel fresh water tank for the wash basin is located in the interior of the coach behind the wall mirror. A large overflow line is provided on the fresh water tank to eliminate the possibility of damage by excessive water pressure.

TOWEL AND TISSUE DISPENSERS

A towel dispenser is mounted on the inside of the lavatory above the sink. An optional "Towelette" wet towel dispenser may also be mounted in this location. These towels can be used for washing and drying. A tissue dispenser is mounted at the lavatory front wall. A key is furnished for refilling dispenser.

SOAP DISPENSER

To refill the liquid soap dispenser, unscrew the plunger cap which is threaded into the dispenser body. Remove cap and pour liquid soap into dispenser tank until full. Replace plunger cap into dispenser body.

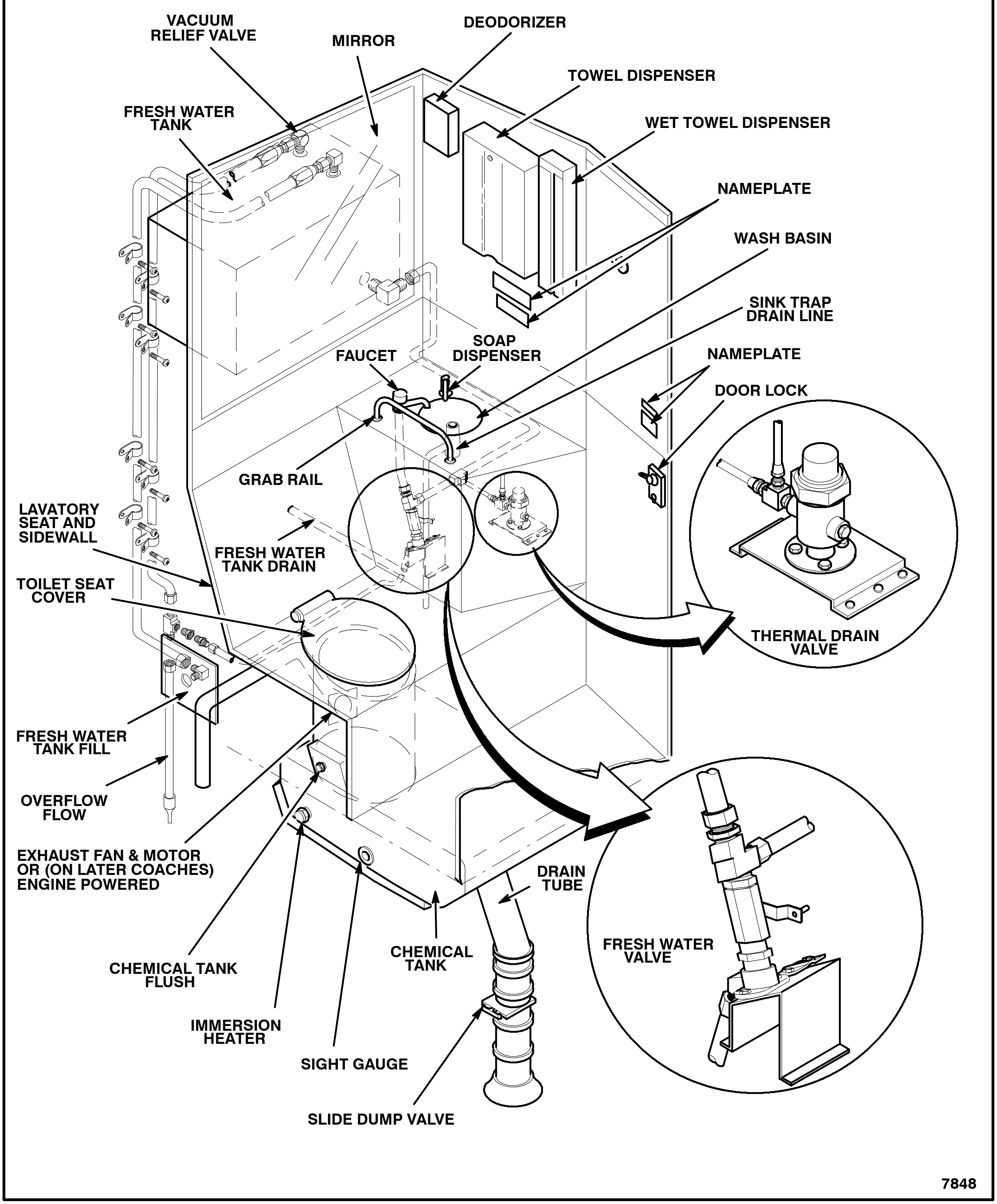

VACUUM RELIEF VALVE
MIRROR
DEODORIZER
TOWEL DISPENSER
FRESH WATER TANK
WET TOWEL DISPENSER
NAMEPLATE
WASH BASIN
SINK TRAP DRAIN LINE
SOAP DISPENSER
FAUCET
NAMEPLATE
DOOR LOCK
GRAB RAIL
LAVATORY SEAT AND SIDEWALL
FRESH WATER TANK DRAIN
TOILET SEAT COVER
THERMAL DRAIN VALVE
FRESH WATER TANK FILL
OVERFLOW FLOW
EXHAUST FAN & MOTOR OR (ON LATER COACHES) ENGINE POWERED
DRAIN TUBE
FRESH WATER VALVE
CHEMICAL TANK
CHEMICAL TANK FLUSH
IMMERSION HEATER
SIGHT GAUGE
SLIDE DUMP VALVE
7848

Figure 1. Lavatory Components

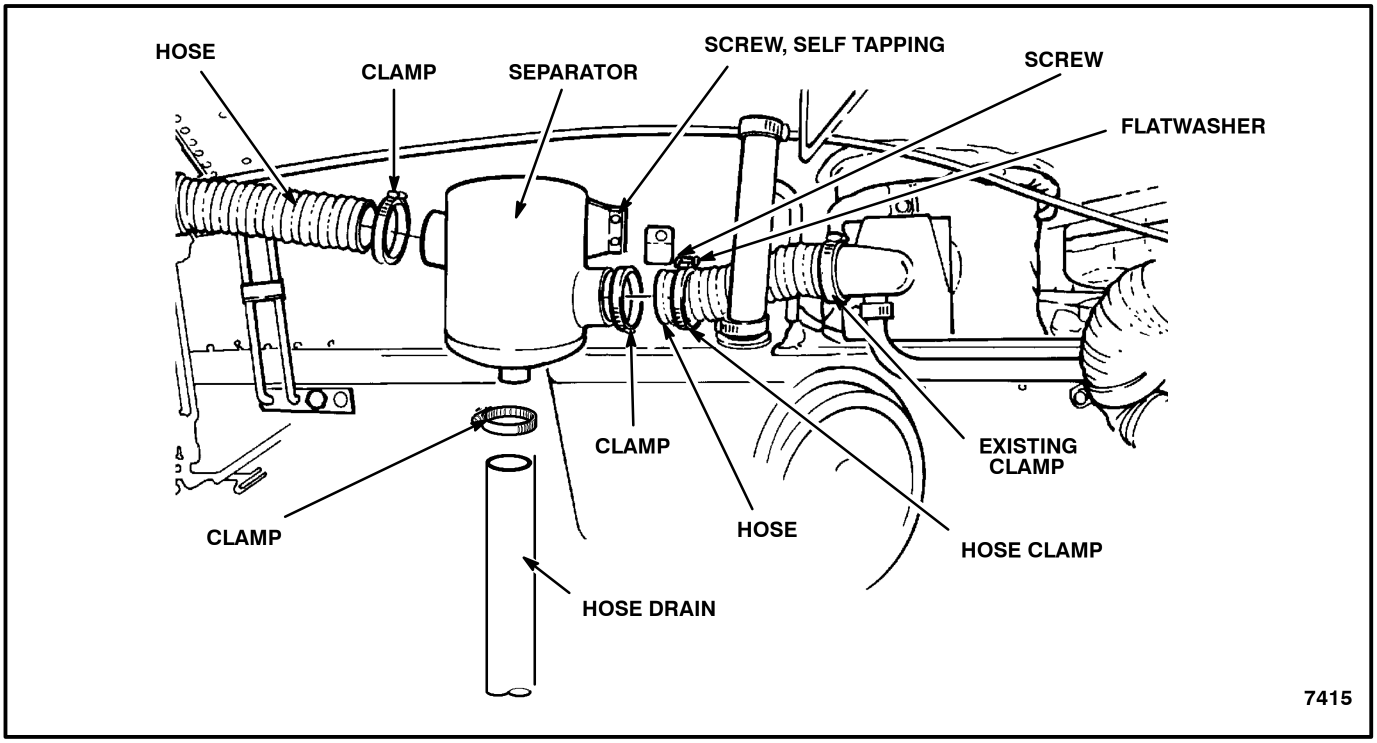


Figure 2. Vacuum Operated Lavatory Ventilation System

DOME LIGHT

A microswitch is installed in the door post at the edge of the front partition. This switch is activated by the door lock mechanism upon locking to energize the dome light and the “Washroom Occupied” sign on the outside wall. The switch is readily serviced by removing the two screws securing the striker plate to the post.

The lavatory dome light contains a 6-candlepower bulb that lights with the marker lights and a 32-candlepower bulb that lights when the door is closed and locked.

LAVATORY SERVICE PANELS

The chemical tank flush and fill service panel is located above the interior of the right-hand rear side service door front. A Hansen 6000 series quick connector is provided for filling of the chemical waste tank. A remote flush button is also installed. A separate fresh water fill service panel is located to the rear of the flush and fill panel. A Hansen 5000 connection is also provided for filling of the storage tank.

NOTE: Prior to unit #45959 the fresh water storage fill was located on the exterior rear panel.

EMERGENCY BUZZER

The lavatory emergency buzzer is mounted in the front junction box and sounds when the emergency switch button in the lavatory compartment is pushed. Refer to wiring diagram for circuit continuity.

The emergency buzzer switch marked “To Signal Driver Emergency Only” is located on upper right corner of the front partition of the lavatory compartment. A light on the instrument panel marked “Lavatory Alarm” illuminates and a buzzer sounds when the switch is depressed.

DEODORIZER

A block refill-type deodorizer is mounted on the side compartment partition. To install a new block, open the grille cover and place the block on the platform.

OCCUPIED SIGN

A lavatory occupied sign light is located on the exterior of the forward lavatory compartment partition. This sign which reads “Wash Room Occupied” is illuminated when the lavatory door is closed and locked.

DOOR LOCK AIR CYLINDER

An air-operated air cylinder is installed to provide positive closing of the lavatory door. The cylinder also reduces rattles and strain on lock, striker plates and hinge.

The cylinder is fed from the coach accessory air supply (4). A pressure regulating valve (2) and a flow control valve (3) assure a controlled closing action (Figure 6). Refer to Section 4, Brakes and Air System, for detailed maintenance of regulating valve.

OPERATION

VACUUM VENTILATION SYSTEM

The lavatory ventilation system operates off the engine vacuum. A large air hose connects the lavatory drop tube to a cyclone type separator and then to the engine air intake box. The constant vacuum thus applied to the drop tube causes a continuous flow of fresh air from the duct on the outer wall of the lavatory to pass through the lavatory compartment. A drain line from the air exhaust elbow on the drop tube keeps moisture from accumulating in the exhaust hose and from entering the air intake box (Figure 2).

FLUSH PUMP

The flush toilet's air-operated diaphragm pump is actuated by the flush button located on the wash basin side panel. Internal flush and recovery valves control the flow of waste water into and out of the pump assembly (Figure 3).

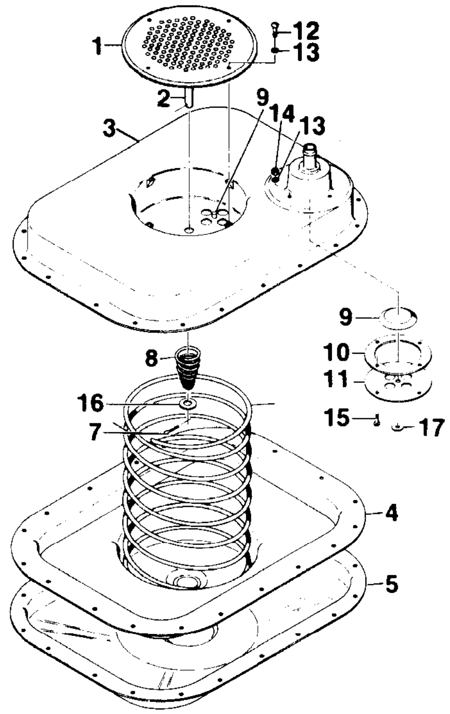
Flush Cycle

When the flush button is actuated, regulated (11 psi) air from the accessory air system flows through the flush pump's inlet valve on the lower pan. Air entering the lower pan forces the inner diaphragm up, pressurizing the water and closing the waste water inlet valve.

Water trapped between the diaphragm and upper pan is forced out the supply tube to the bowl rinse ring. The water also forces the comb up into the grid to stop solids from entering the pump mechanism. Flush cycle will continue until all waste water in the recovery reservoir is used.

Recovery Cycle

When the button is released, the air is exhausted from the lower pan via the quick release valve. The outlet valve to the bowl closes and the inlet valve opens. The return spring tension returns the diaphragm to the "at rest" position. Reduced pressure allows the comb to lower which opens the grid to allow the pump mechanism to fill with a new waste water charge.



1. **Grid**
2. **Comb**
3. **Upper Pan Assy.**
4. **Spring Housing Pan Assy.**
5. **Lower Pan**
6. **Spring**
7. **Cotter Pin**
8. **Conical Spring**
9. **Pump Valve**
10. **Gasket**
11. **Valve Plate**
12. **Pan Retaining Screw**
13. **Washer**
14. **Self-Locking Nut**
15. **Screw**
16. **Washer**
17. **Washer**

6931

Figure 3. Air Flush Pump Components

MAINTENANCE

SOAP DISPENSER

To refill the liquid soap dispenser, Remove plunger cap and pour liquid soap into dispenser tank until full. Replace plunger cap into dispenser body.

Periodic cleaning of soap dispensing equipment should be made a regular part of your washroom cleaning routine and general maintenance program. Never use abrasive cleaners on parts of the soap dispenser as this will mar the surface. The exterior of the soap dispenser should be washed with warm soap and water, then dried with a clean cloth. Sometimes a dispenser may become clogged and it will be necessary to remove the soap dispenser for cleaning.

As part of your regular routine, make it a practice to check the operating condition of the soap dispensing piston mechanism at regular intervals to make sure it works freely. If it is not working, disassemble and wash all metal parts in soap and water and let dry. Assemble and replace in service.

CHEMICAL TANK

Draining and Recharging

A special hopper or collection point in the floor of the service area equipped with proper flush down facilities should be used to dispose of waste contents of the lavatory system. Refer to local health regulations for proper disposal procedures and/or equipment. To service the chemical tank follow this procedure.

1. Drain the chemical waste tank by pulling out on the handle of the slide dump valve.
2. Press flush button after draining to remove most waste water from tank, and push the slide valve handle in to the closed position (Figure 4).

NOTE: Non-flush holding tanks should be rinsed thoroughly before recharging with chemical disinfectant.

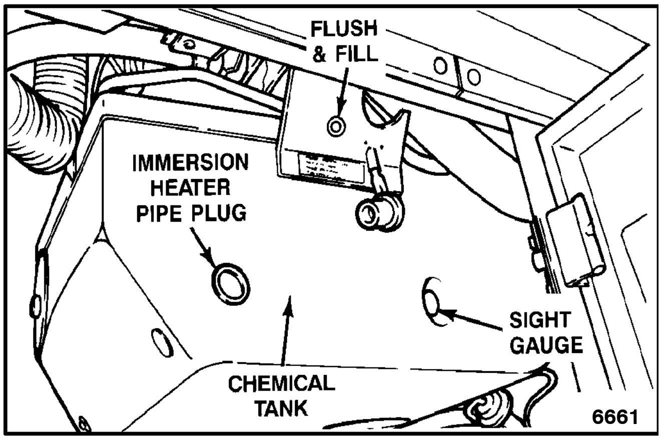


Figure 4. Lavatory Service Panel

3. Fill the tank with fresh water to the sight glass, and press flush button to rinse tank. Open the slide valve handle to drain tank.
4. Close the slide valve handle and recharge the chemical tank to the sight glass level. Press the flush button to charge pump with new chemical solution.

NOTE: Pour 1/3 pint (.15 liters) of Kilgerm or equivalent disinfectant into chemical tank. This chemical mixed with water will properly charge the chemical tank. Refer to the suppliers listing at the end of the section for appropriate disinfecting and deodorizing chemicals

Winterizing

Although disinfectant may freeze below +30°F (−1°C.), the performance of the chemical will not be affected upon thawing. The most economical way to protect the tank should it be exposed to extreme cold temperatures, is to install an electrically operated immersion heater into tank. Use an anti-freeze solution such as ethylene glycol in the waste chemical tank along with the disinfectant. Based on the expected average low temperature and the quantity of waste in the waste chemical tank, charge the tank as follows:

Percentage of Antifreeze Required in Tank

	25%	33%	40%	50%
Protects To:	+0°F (−12°C)	0°F (−17°C)	−12°F (−24°C)	−34°F (−36°C)

⚠ CAUTION ⚠

Do not use automotive "stop-leak" formulas in the chemical tank. These compounds may cause coagulation of the flushing fluid when mixed with high quality deodorizing additives.

NOTE: For better odor control the amount of chemical should be increased when used in conjunction with antifreeze.

Cleaning & Inspection

NOTE: The chemical tank incorporates a large cleanout hole at rear for inspection, cleaning or removal of solid objects (Figure 5).

After draining and rinsing completely, the assembly may be cleaned by scrubbing the inside and outside surfaces with a solution of soap and water or five tablespoons of liquid disinfectant to each gallon of water. Do not use abrasive cleaners on any part of the assembly. Rinse thoroughly with hot water and dry using compressed air.

A thorough cleaning is essential prior to inspection for determining the existence, location, and extent of any defects. The holding tank should be periodically inspected for leakage.

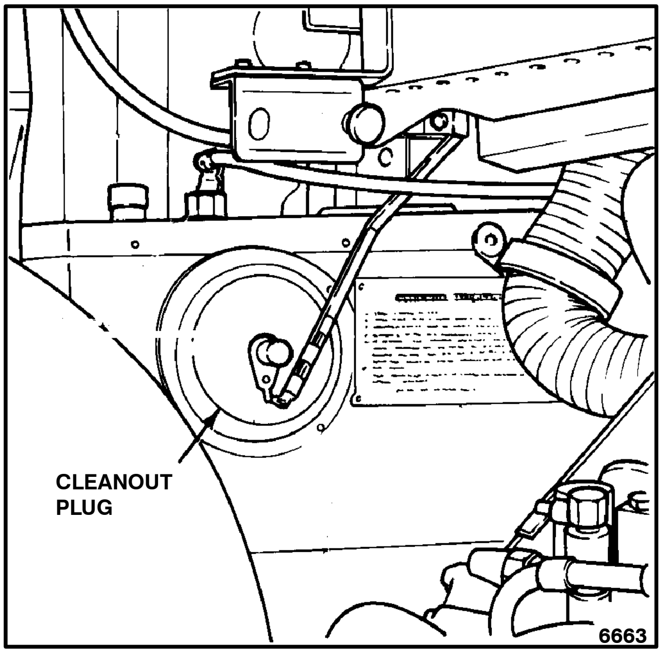


Figure 5. Chemical Tank Cleanout

Removal

1. Turn battery disconnect switch to “OFF”.

NOTE: Drain air system completely before removal of a flush type tank.

2. Drain and clean the waste chemical tank as described under “Cleaning and Inspection” above.
3. Unfasten and disconnect all hoses to tank and drop tube assembly. Remove dump tube and slide valve assembly.
4. Disconnect the drop tube from the tank flange, and unfasten support brackets from coach frame.
5. Remove tank from engine compartment, and remove outer fiberglass covers.

Installation

1. Reinstall in reverse order of “Removal” procedure. Use silicone to seal tank and drop tube flanges. Torque capscrews to 20 ft-lbs.

FLUSH PUMP

Removal

1. Turn battery disconnect switch to “OFF”, and drain air system completely.
2. Drain and clean the waste chemical tank as described under “Cleaning and Inspection” above.
3. Unfasten and remove the bottom cover of tank. Remove air line from lower pan assembly. Remove the rinse tube from pump nozzle.
4. Remove the (20) brass hex nuts that mount the air pump assembly to the tank.

NOTE: Do not remove the six (6) small hex nuts until ready to disassemble and separate both pump halves.

5. Gently lift studded ring off pump, Remove pump assembly from tank gasket and carefully pass it through the pump cutout in the tank bottom.

Disassembly

⚠ **WARNING** ⚠

Pump assembly spring is compressed to 25 lbs. (11.3 kg) pre-load. Exercise care during disassembly.

1. Unfasten and remove upper and lower pan attachment bolts and break assembly apart.
2. Remove retaining ring securing comb and grid.
3. Remove cotter pin securing conical spring. Remove spring and comb stem.
4. Remove screws securing pump valve to flush outlet port.
5. Remove plate and gasket from pump valve.
6. Remove pump valve from flush outlet port.
7. Remove spring from diaphragm retaining area.
8. Use the lavatory flush pump repair kit P/N 17F-2-151 to replace any damaged parts.

Assembly

1. Reassemble in reverse order of “Disassembly” procedure. Use silicone to seal diaphragm to upper and lower pans. Torque hex nuts to 10-20 in-lbs.
2. Air test pump assembly and check for any leakage.

Installation

1. Reinstall in reverse order of “Removal” procedure. Use silicone to seal pump gaskets to tank. Torque stud ring hex nuts to 10-20 in-lbs.
2. Fill tank to sight glass and test flush function of pump assembly and check for any tank leakage.

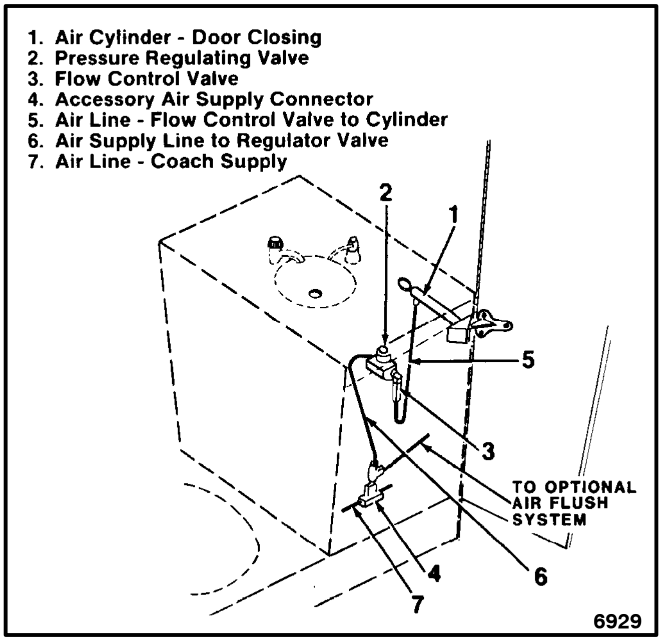

1. Air Cylinder - Door Closing
2. Pressure Regulating Valve
3. Flow Control Valve
4. Accessory Air Supply Connector
5. Air Line - Flow Control Valve to Cylinder
6. Air Supply Line to Regulator Valve
7. Air Line - Coach Supply
2
1
5
3
TO OPTIONAL AIR FLUSH SYSTEM
4
6
7
6929

Figure 6. Door Air Closing Mechanism

DOOR LOCK AIR CYLINDER

The lavatory door air closing mechanism should be periodically checked for proper operation and attachment (Figure 6). The regulator should also be checked for correct pressure setting. Refer to Section 4 for detailed maintenance of regulating valve.

Lubricated the air cylinder every 30,000 miles (48,000 km) using lubrication specification (S-6 - Light Oil). To lubricate, remove air feed hose and put a few drops of oil into the air hose connector.

Removal

1. Turn battery disconnect switch to “OFF”, and drain air system completely.
2. Remove hinge cover and disconnect air line.
3. Unfasten and remove retaining clevis pin, and unscrew cylinder from remaining rod end..

Installation

1. Reinstall in reverse order of “Removal” procedure.
2. Test closing function before attaching cover and check for any air leakage.

> **NOTE:** When overhauling air cylinder, it is important to replace all seals, felts, cups and O-rings with new parts for proper operation. Also when overhauling cylinder, the new parts should be coated with oil before assembly.

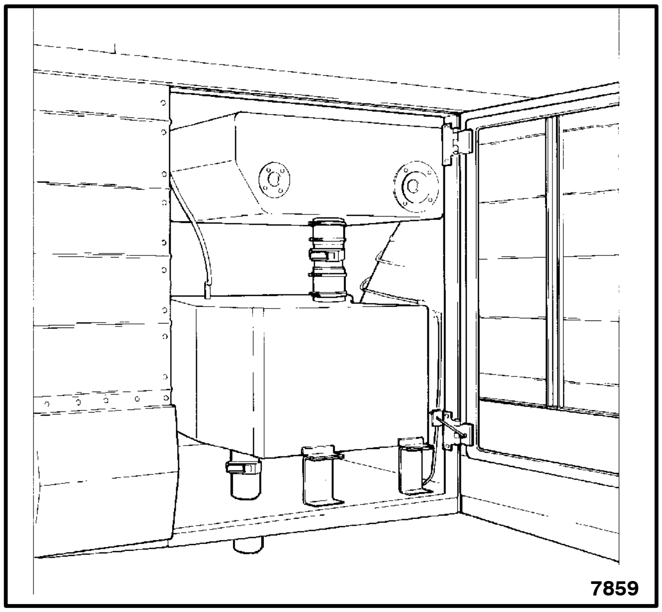


Figure 7. Auxiliary Retention Tank

AUXILIARY RETENTION TANK

The optional auxiliary retention tank has a 13.4 U.S. gallon capacity, and is located directly below and connected to the main tank. With the auxiliary retention tank the operator is provided with additional waste storage when waste disposal facilities are not available (Figure 7).

> **NOTE:** Periodic visual inspections should be made of the tank interior for foreign objects and/or excessive buildup in the tank corners due to lack of proper rinsing.

Removal

1. Turn battery disconnect switch to “OFF”,
2. Drain and clean the auxiliary retention tank as described under “Cleaning and Inspection” above.
3. Unfasten any hoses and disconnect upper and lower slide valve connector hoses to the tank inlet and outlet.
4. Remove lower slide valve assembly from engine compartment.
5. Unfasten the retention tank from the coach frame and remove.

Installation

1. Reinstall in reverse order of “Removal” procedure.

SLIDE VALVE

The manually operated slide dump valve (knife-type gate) is used to drain the main or auxiliary retention tanks. Draining is accomplished by pulling out on the handle of the slide valve (Figure 8).

NOTE: Slide valve handle-to-shaft connections can be either pinned or threaded.

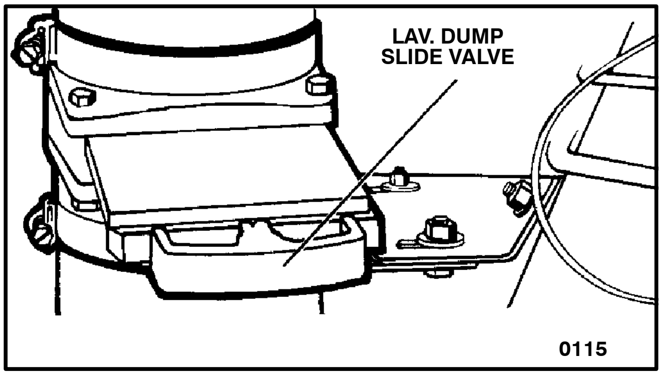


Figure 8. Slide Dump Valve

Removal

1. Turn battery disconnect switch to “OFF”,

2. Drain and clean the tanks as described under “Cleaning and Inspection” above.

3. Unfasten and disconnect slide valve connector hoses from valve assembly and remove.

Installation

1. Reinstall in reverse order of “Removal” procedure. Make sure that the direction of flow is down.

FRESH WATER STORAGE TANK

NOTE: Periodic visual inspection should be made of the tank interior to detect any corrosion.

Removal

1. Turn battery disconnect switch to “OFF”, and drain tank completely.

2. Remove the snap-on molding and track holding the mirror in place and remove mirror.

NOTE: Pull the mirror up from behind the bottom retaining channel and carefully swing out. The fresh water tank, mountings and line fittings are now exposed.

3. Unfasten the tanks inlet and outlet hoses and disconnect any fittings or valve (Figure 9).

4. Unfasten and remove the tank mounting hardware and remove tank from compartment.

Installation

1. Reinstall in reverse order of “Removal” procedure. Refill and check for any leakage before installing mirror.

THERMAL DRAIN VALVE

The optional thermal drain (Ozontz) valve automatically drains the fresh water storage tank when the temperature in the vehicle drops to approximately 34°F (1°C). The valve is mounted to a bracket located below the wash basin (Figure 10).

Inspection & Testing

It is recommended that the thermal drain valve be inspected for leakage at outlet port located in the engine compartment once a year, preferably in the fall. The following procedure should be followed. If there is no leak, temperature above 40°F(4°C), the valve is satisfactory and needs no servicing. If a leakage is evident, repair or replace the valve.

The thermal drain valve can be easily tested for accuracy. The following method is recommended for testing thermal drain valves:

1. After the thermal drain valve has been at room temperature for at least one half hour, pour 45°F (7°C) or warmer water into the inlet of the valve. The valve should be closed and no water should flow.

2. Place the thermal drain valve in a container of ice and cover it with a minimum of water. The water should be about 33°F (1°C).

3. After at least one half hour, remove valve and pour water into inlet port. Water should flow through outlet port of valve.

Removal

1. Turn battery disconnect switch to “OFF”, and drain tank completely.

2. Unfasten and remove valve from bracket.

Disassembly

1. Remove cap, thermal unit, cage, operating spring and bearing plate.

2. Clean seat at bottom of valve body.

3. Reassemble bearing plate, operating bearing spring, cage, thermal valve unit and cap making certain that the cage is properly aligned with the valve port and that the cage assembly is not cocked.

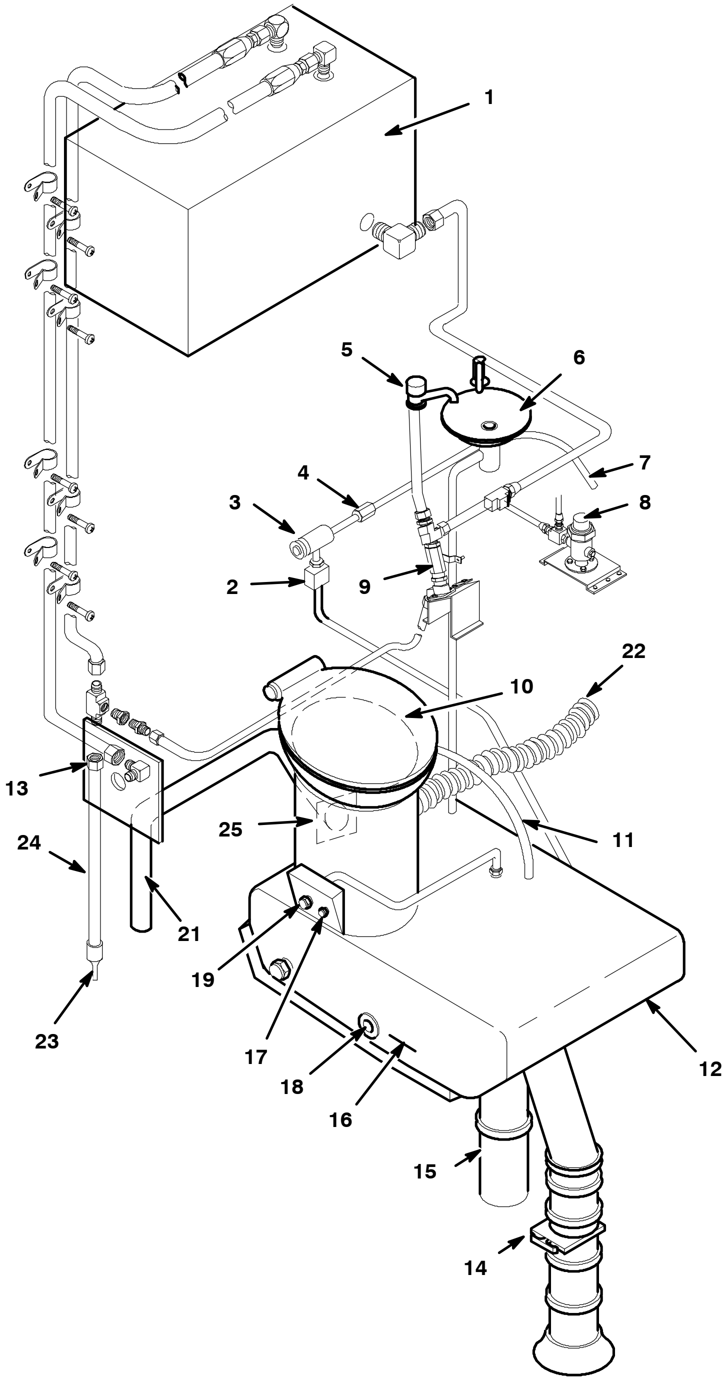
If the valve still leaks, the following procedure should be followed:

4. Remove cap, thermal unit and cage.
5. Remove valve guide and poppet from cage.
6. Install new Buna S poppet and re-install guide.
7. Re-install cage and a new thermal unit.
8. Re-install cap making certain that cage is properly aligned with valve port and that the cage assembly is not cocked.

Installation

1. Reinstall in reverse order of “Removal” procedure. Refill and check for any leakage.

NOTE: In case of a complete replacement of drain valve, make sure to seal around outlet port in engine compartment with mortite tape to prevent fumes from engine compartment entering the lavatory compartment.



1. WATER TANK
2. QUICK RELEASE VALVE
3. PUSH BUTTON VALVE
4. PRESSURE REGULATING VALVE (11 PSI/75.7 kPa)
5. FAUCET
6. BASIN
7. AIR SUPPLY LINE
8. AUTOMATIC WATER DRAIN VALVE
9. MANUAL DRAIN VALVE
10. TOILET SEAT
11. FLUSHING DELIVERY HOSE
12. CHEMICAL TANK
13. FRESH WATER TANK FILL LINE
14. DUMP TUBE
15. AIR CYLINDER*
16. START CHARGE LEVEL
17. AIR DUMP VALVE*
18. SIGHT GLASS
19. IMMERSION HEATER PROVISION
20. CHEMICAL TANK FLUSH & FILL TUBE
21. EXHAUST FAN OUTLET (ON EARLIER COACHES)
22. ENGINE POWERED EXHAUST (ON LATER COACHES)
23. RUBBER VALVE
24. FRESH WATER TANK OVERFILL TUBE
25. EXHAUST FAN MOTOR

* PART OF OPTIONAL AIR DUMP VALVE SYSTEM

Figure 9. Lavatory Plumbing

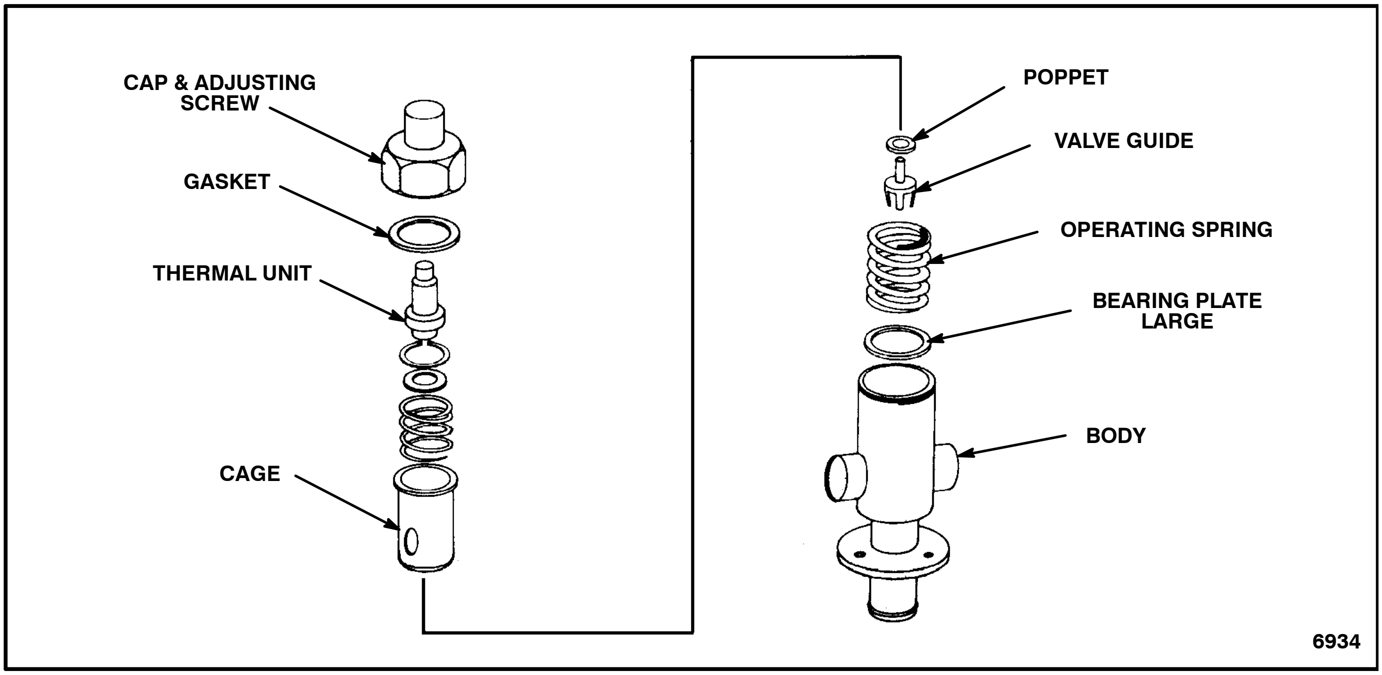


Figure 10. Thermal Drain Valve

TROUBLESHOOTING

TROUBLE	CAUSE
TOILET WILL NOT FLUSH Pushbutton will not reset, air leaking can be heard.	Air line from pump assembly to control valve broken or disconnected or cracked or broken lower pan housing.
Air regulator hissing.	Defective air regulator.
Water in the air line from pump to pushbutton.	Pump diaphragm broken.
Comb stuck in up position.	Replace comb and grid, or replace conical spring if broken.
Pump is functioning but no water in the bowl.	Broken water line from pump assembly to bowl.
SHORT FLUSHING CYCLE (10 SECONDS OPTIMUM)	Bubbles in the flush pattern. Hole in the water hose from pump assembly to bowl.
Comb will not reach full height during flush cycle.	Excessive buildup of debris between pins of comb.
Water bubbling in grid area.	Defective valve in the comb housing area.
AIR BUBBLES IN THE FLUSH Water level below comb pins.	1. Recharge with water and chemical DG-19C. 2. Insufficient amount of water pre-charge. 3. Water in the air line from pump to pushbutton. 4. Small hole in the pump diaphragm.

SPECIFICATIONS

CHEMICAL TANK ASSEMBLY

Manufacture	MCI
Part Number (Non-Flushing)	17G-2-45
Part Number (Flushing)	17G-2-43
Capacity	20 gals. (76 liters)

AUXILIARY RETENTION TANK ASSEMBLY

Manufacture	MCI
Part Number	17K-2-50
Capacity	16 gals.

SLIDE DUMP VALVE

Manufacture	Valtera
Part Number (Pinned Handle)	17K-5-54
Part Number (Threaded Handle)	17K-5-51

FRESH WATER STORAGE TANK ASSEMBLY

Manufacture	MCI
Part Number	17L-2-18
Capacity	10 gals.

LAVATORY SERVICE PANEL VALVES

Manufacture	Hansen
Part Number (Chemical Tank Fill and Rinse)	17B-5-50 (6000 Series)
Part Number (Fresh Water Fill)	17M-5-12 (5000 Series)
Part Number (Flush Button)	17F-5-58

CHEMICAL TANK DEODORANT AND DISINFECTANT SUPPLIERS

SUPPLIER	TRADE NAME
Monogram Sanitation	Tank Chemical (P/N17C-1-78)
Vapor Corporation	DG-19C
Zep Products	Honest John
Celest Industries	Sani-Pak
Leeder Chemicals	Commode Magic

SERVICE BULLETINS

Service Bulletins will be issued from time to time to acquaint users with the latest service procedures. The number, date and title of bulletins pertaining to this section should be noted below as soon as received. Bulletins should then be filed for future reference.

Number	Date	Subject

102D SERIES
RICON F9000 WHEELCHAIR LIFT
MAINTENANCE MANUAL SUPPLEMENT
P/N 3L-15-1574A JANUARY, 1997

This Supplement is used in conjunction with the 102D Series Maintenance Manual. When servicing a Ricon wheelchair equipped coach, refer to this supplement first to identify any specialized wheelchair coach information. Only MCI installed components are addressed by these supplements. If the information you seek is not in the supplements, please refer to the basic manual information or the Ricon Service/Owner's Manual provided with your coach.

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LIFT COMPARTMENT AND ACCESS DOOR A-14

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LIFT ASSEMBLY

GENERAL DESCRIPTION

Coaches equipped with the Ricon® wheelchair lift have the capabilities of safely on-loading, securing for travel and off-loading two (2) wheelchair passengers in addition to the normal passenger compliment. The lift module is located inside the #2 RH baggage bay, and can easily be access from the sidewalk. The lift is operated by a pendant control switch located on the inside of the lift enclosure baggage door. The lift utilizes an electro-hydraulic power system to perform normal loading and unloading operation, and features an additional emergency manual back-up.

⚠ WARNING ⚠

A minimum of 60 inches of clear area in front of the lift is required during operation.

The platform assembly and bridgeplate assembly, travel frame assembly, carriage assembly and lift enclosure are factory assembled into a space saving cassette type module. This cassette module is hung from and securely fastened to the coach framework at top of the #2 RH baggage bay. The wheelchair lift, when in operation, occupies the area in front and above the #2 baggage compartment (Figure 1).

The lift enclosure baggage door features keyed access, and incorporates a safety interlock switch along with a keyed power switch to ensure against accidental deployment. Other lift components including the electrically operated pump, emergency hand pump and fluid reservoir are located inside the control box mounted to the rear of the #1 RH baggage compartment.

Coach access for wheelchair passengers is through the hinged sidewall access door. The door is outward opening and extends from the passenger compartment floor level to the roof. When opened it allows for the lift platform assembly to be completely deployed across the entire width of opening. The door features keyed access, and incorporates a safety interlock switch. When opened to its maximum, (approximately 90 degrees), the door should automatically self-lock, to avoid interference with lift operation.

Two spaces can be provided to securely retain wheelchair passengers while traveling. The first space is located next to the lift platform, with another located directly across the aisle from the lift. Special seats that fold and slide away on tracks are located at both wheelchair parking areas.

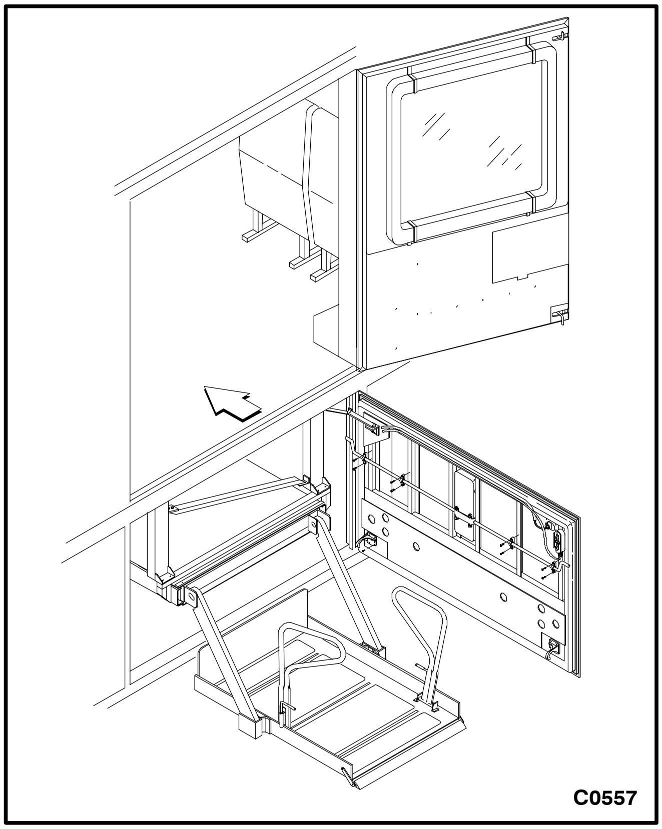

Figure 1. Lift Area

Restraining straps securely attached to floor clamps retain wheelchair during travel, along with a passenger lap belt and an interconnecting shoulder harness (Figure 2). Special floor coverings on the lift platform and in wheelchair parking areas provides proper traction for the wheelchairs.

COMPONENTS

CONTROL BOX

Power Unit

The power unit consists of an electric motor coupled to a hydraulic pump. The pump and motor are mounted to an electrically piloted solenoid controlled manifold, and actuated by the push button pendant control switch. Fluid is pumped to the lift cylinder to lift platform, and released to return to the reservoir to lower the platform. The pump is supplied by an attached four quart reservoir (Figure 3).

Manual Release Valve

The valve is located on the side of the hydraulic hand pump, and controls the lift's emergency functions (Figure 3).

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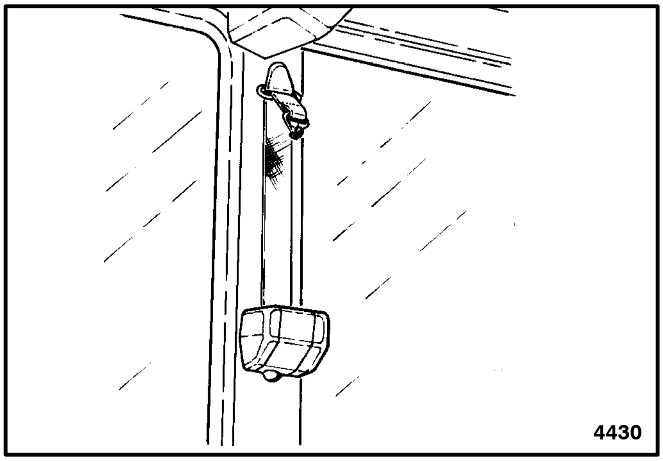


Figure 2. Shoulder Restraint

Emergency Hand Pump (Hydraulic)

The hand pump is located in the control box, and is piped into the lift system's hydraulic circuit for use in emergency situations (Figure 3).

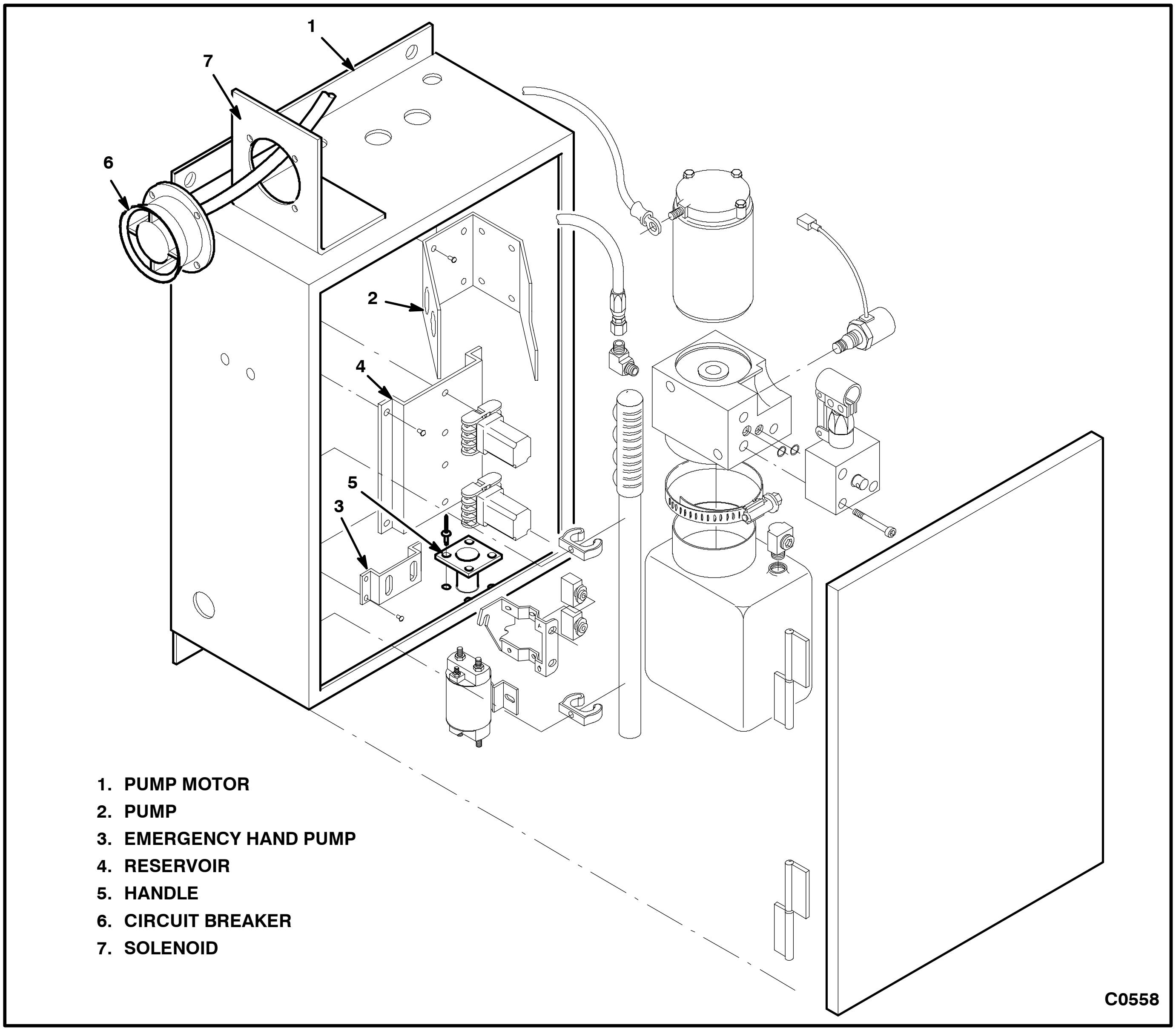
Circuit Breaker & Solenoid

The lift control box electrical system is protected by one 30 Amp and one 5 Amp circuit breaker located inside the lift control box. The pump motor solenoid is also located in this box.

LIFT MODULE

Platform & Bridgeplate Assembly

The lift platform supports the wheelchair while lift is in motion. The platform consists of a main section with a front hinged ramp/barrier edge. The rear bridgeplate


1
7
6
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5
3
1. PUMP MOTOR
2. PUMP
3. EMERGENCY HAND PUMP
4. RESERVOIR
5. HANDLE
6. CIRCUIT BREAKER
7. SOLENOID
C0558

Figure 3. Control Box Components

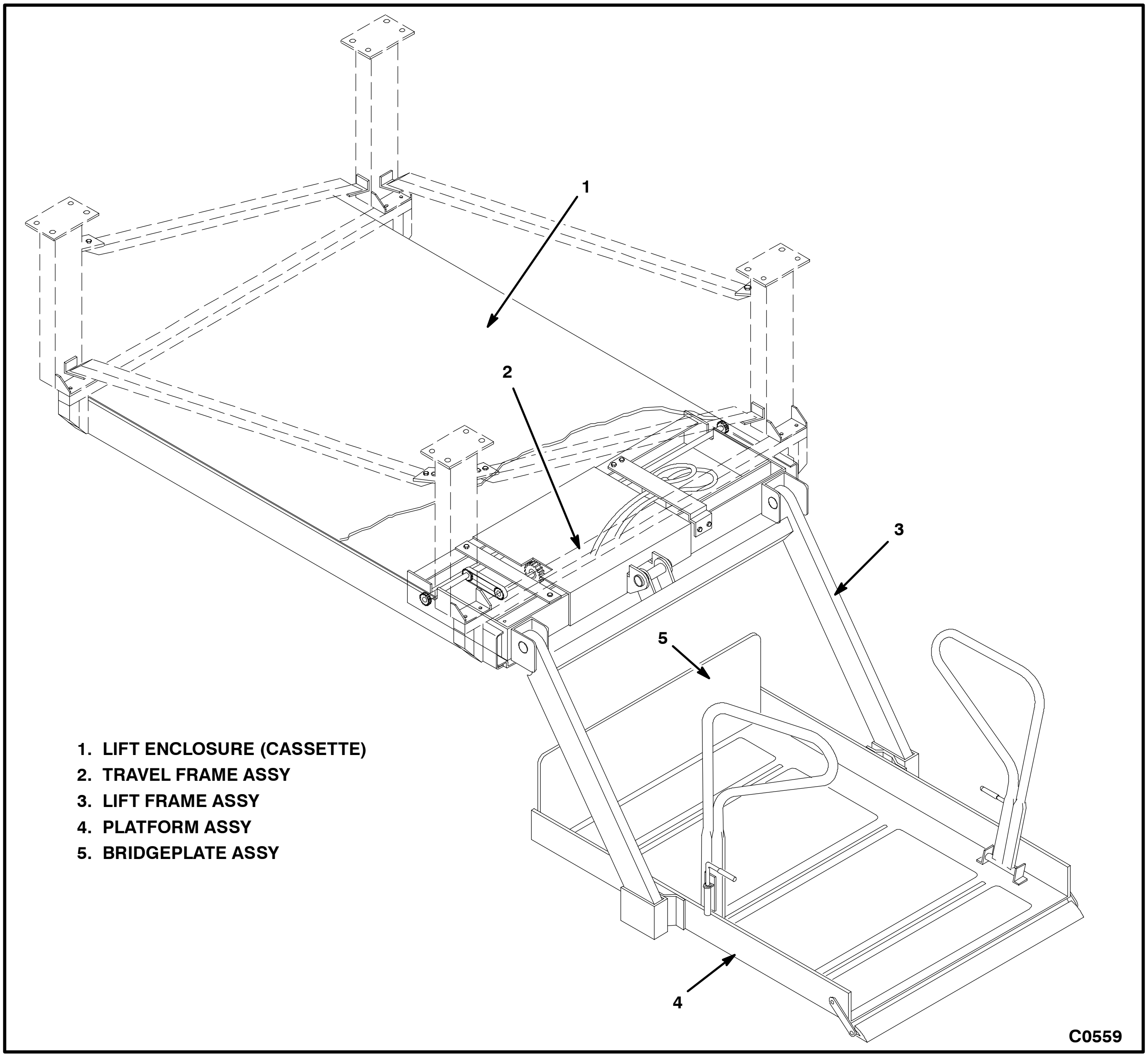

Figure 4. Main Lift Components

assembly is also a hinged ramp/barrier that automatically deploys once the platform reaches coach floor height (Figure 4). The platform also incorporates two hinged handrail assemblies with restraint belt safety interlock device. A slam lock assembly locks the handrails in the upright position.

Traveling Frame Assembly

The traveling frame assembly contains the hydraulically operated carriage assembly mechanism and the lifting frame assembly of the module. Additionally, the traveling frame supports the platform and bridgeplate assemblies (Figure 4).

Carriage Assembly

The carriage assembly consists of a frame for attaching the gear motor reduction units and also the hydraulic lift cylinder which attaches to the rear of the lifting frame (Figure 4).

Lift Enclosure

The lift enclosure assembly or cassette provides the attachment points for mounting of the lift to the coach framework (Figure 4). The cassette also allows the traveling frame to move atop guide rails inside the lift enclosure assembly during deploy and stow operations.

MISCELLANEOUS ELECTRICAL

Push Button Pendant Switch Assembly

The push button pendant switch assembly controls the lift function Up/Down of the lift power unit and the stow In/Out movement of the carriage drive motor. The Up/Down and In/Out switches are momentary on type, while the Lift/Stow switch is a positive type. The pendant switch assembly is mounted on the upper right hand inside corner of the #2 baggage door (Figure 5).

Wheelchair Master Switch

A keyed master On/Off switch is located on the upper left-hand instrument panel (Figure 6). This switch will energize coach safety interlock circuits and enable the secondary lift compartment keyed switch when in the "ON" position.

Lift Switch

A secondary keyed lift switch, located inside the lift compartment door frame, must be activated to energize the push button pendant switch assembly. The wheelchair master switch key is also used for the secondary lift switch (Figure 7).

Circuit Breaker Protection

The wheelchair lift electrical system is protected by a main 105 Amp main circuit breaker located in the battery compartment in front of the coach main circuit breaker. Two other breakers 30 Amp and 5 Amp are located in the lift control box.

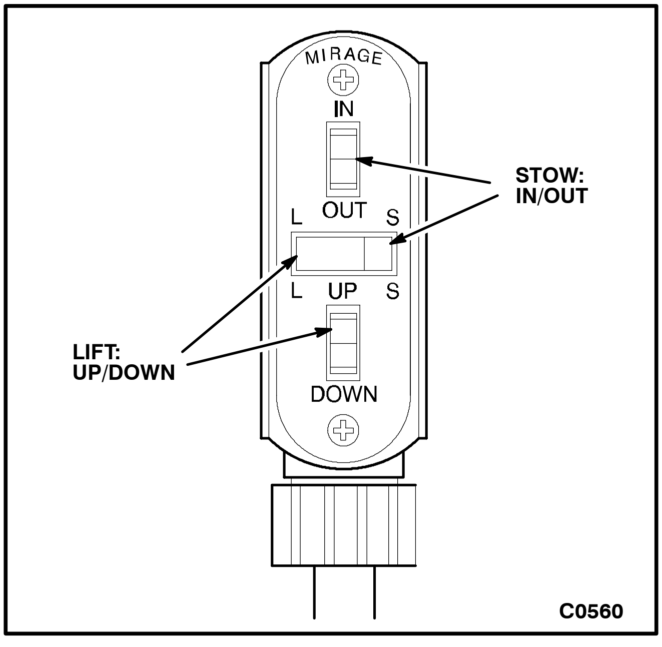

Figure 5. Lift Pendant Switch

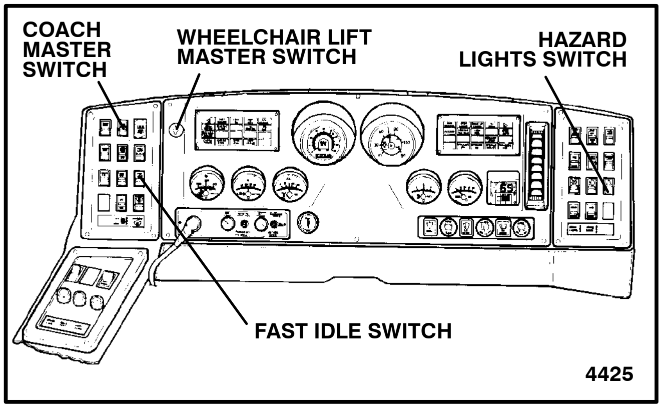

Figure 6. Master Lift Keyed Switch

Lift & Access Door Safety Interlock Circuit

The coach safety interlock circuit will disable transmission shift and throttle control. The circuit will also set the park brake and begin engine fast idle. The circuit is energized whenever the lift compartment door or wheelchair access door is open, or when the master lift switch is keyed "ON". Additionally, the interlock circuit includes hazard lights and audible alarm which are only energized when doors are opened and master switch is "ON" (Figure 8).

NOTE: The wheelchair lift is not enabled until both switches are "ON" and both doors are open.

⚠ WARNING ⚠

The safety interlock circuit remains energized until both doors are closed and wheelchair master switch is "OFF".

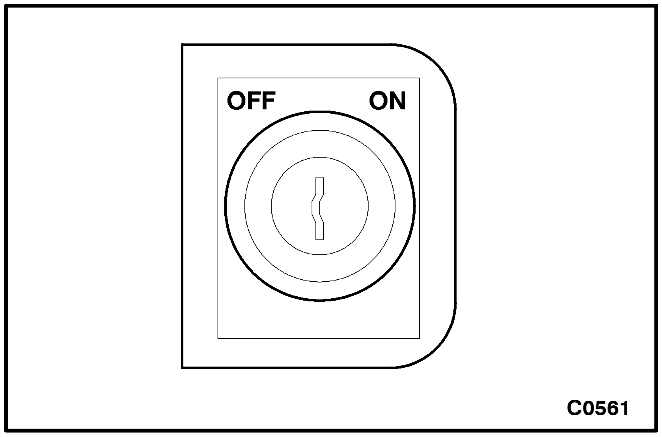

Figure 7. Secondary Lift Keyed Lock

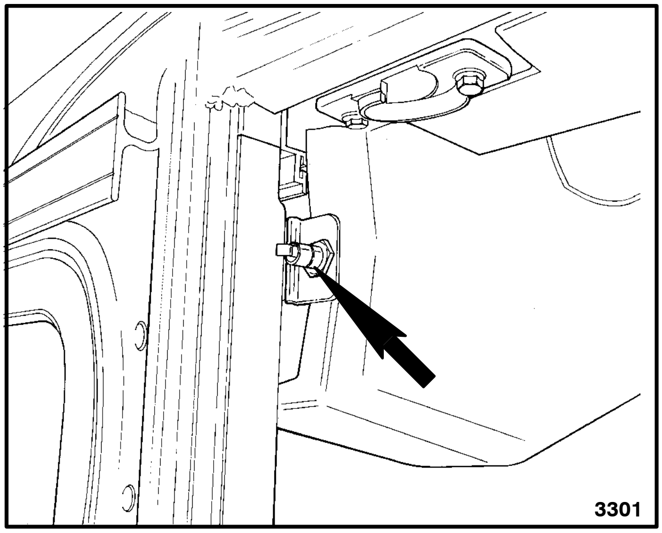

Figure 8. Door Safety Interlock Micro-Switch

OPERATION

The wheelchair lift can be operated in either the normal mode (electrically) or in emergencies situations by the manual mode (hand-operated pump).

Normal operation utilizes the pendant control assembly for routine deployment, lifting and stowing operations. The pendant control switch is enabled only when both master and secondary keyed switches are "ON". When the lift is operated in this manner the travel motor and hydraulic pump are energized.

In emergency situations a manual mode is used for lowering passengers and stowing operation. When the wheelchair lift is operated in this manner the hand pump provides hydraulic pressure to the lift cylinder. A manual pressure release is used to lower the lift. The lift must be stowed manually by pushing it back into the cassette.

⚠ **WARNING** ⚠

The manual mode should never be used for boarding of passenger, only for the emergency lowering of passengers and stowing of lift.

Both the electrically controlled power unit pump and valves, and the manually operated hydraulic hand pump and release valve are located in the front right-hand baggage compartment's control box. All hydraulic hoses and electrical control harnesses are routed through the baggage compartment wall and into the lift cassette.

⚠ **WARNING** ⚠

This lift is designed for use by wheelchair and standee occupants only. Improper use of the lift can result in personal injury.

Do not exceed rated load capacity of 660 pounds (300 Kg).

Prior to use, inspect wheelchair lift for proper function, required maintenance or damage. If a problem exists, do not use lift.

Do not deploy lift if coach is not on level surface. A sloping condition could cause wheelchair to roll off lift platform.

All personnel charged with wheelchair lift operation must be trained, and know all the procedures for the wheelchair lift's normal and emergency operation before operating the lift with passengers aboard.

Lift Deployed To Enter Coach (Normal Mode)

1. Stop the coach within two feet of the curb.
2. Shift the transmission to neutral and apply the park brake.
3. Turn the dash mounted wheelchair lift master switch to "ON", and remove the key for use on the secondary switch.
4. Position the slider seat(s), if in a wheelchair parking area. Refer to seat operation later in this section.
5. Unlock and open the access door until slider prop bar is engaged in door channel.
6. Unlock and open the lift compartment door until prop bar is engaged.

NOTE: If there is not an extra ignition key, the engine must be shut down, the lift door unlocked, and engine restarted before performing step 3.

7. Energize the lift by turning the secondary lift switch to "ON" with the master switch key.

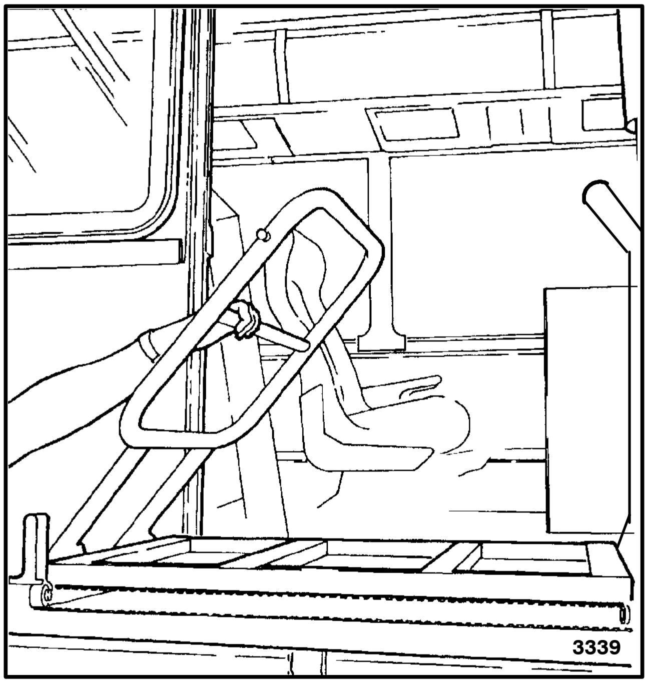

Figure 9. Wheelchair Lift Handrail

8. Position pendant switch to (S) “STOW” and press the “OUT” portion of the upper button.

NOTE: The momentary-on In/Out switch must be held until the lift has completely extended out of the cassette before the lift function is enabled. A complete extension is characterized by a load clicking sound of the clutch mechanism. When extended, the bridgeplate assembly will automatically flip up.

9. Unbuckle restraint belt, and rise both handrail assemblies to the vertical (locked) position (Figure 9). After raising handrails reconnect the restraint/interlock belt for continued lift operation.

10. Position pendant switch to (L) “LIFT” and press the “DOWN” portion of the lower button.

NOTE: When lowered, the rollstop assembly will deploy automatically by mechanical actuator assembly. Rear of lift should be approximately 3/4“ to 1“ off the ground.

Passenger Loading (Normal Mode)

1. Position wheelchair on lift platform, and manually raise the rollstop.

⚠ **CAUTION** ⚠

Wheelchair passengers should always be loaded facing outward from the coach with the small wheelchair wheels against rollstop, with wheelchair brake set. Electric wheelchairs must be loaded and unloaded manually. Standees may face coachward.

2. Fasten the wheelchair restraint/interlock belt across the lap of wheelchair occupant.

NOTE: The lift will not function in the Up/Down mode until restraint/interlock is connected.

3. Position pendant switch to (L) “LIFT” and press the “UP” portion of the lower button.

NOTE: When raised the rollstop will automatically set. At coach floor level, the bridgeplate assembly will automatically deploy across coach threshold gap.

4. Position and securely restrain both wheelchair and passenger within a parking area using the proper restraints.

Lift Stowage (Normal Mode)

1. Refasten the wheelchair restraint/interlock for lift operation.

2. Position pendant switch to (S) “STOW” and press the “DOWN” portion of the lower button.

NOTE: Platform will slow and stop slightly above or below the exact stow level depending on direction of travel.

3. Unfasten the wheelchair restraint/interlock, release handrail locks and fold handrails down onto platform by pulling up on the slamlock handle that secures handrail to platform skirt. After folding handrails, reattach the restraint/interlock for continued stowage operations.

4. Position pendant switch to (S) “STOW” and press the “IN” portion of the upper button.

NOTE: The momentary-on In/Out switch must be held until the lift has completely retracted into the cassette. When retracted, the bridgeplate assembly will automatically fold over onto platform.

5. Turn power off to the lift by turning the secondary lift switch to “OFF” with the master switch key.

6. Close and lock both doors for coach travel.

7. Turn the wheelchair master lift switch to “OFF”.

Lift Deployed To Exit Coach (Normal Mode)

1. Proceed with steps #1 thru #7 of the previous “Lift Deploy (Normal Mode)” instructions.

2. Position pendant switch to (S) “STOW” and press the “OUT” portion of the upper button.

3. Unbuckle restraint belt, and rise both handrail assemblies to the vertical (locked) position. After raising handrails reconnect the restraint/interlock belt for continued lift operation.

4. Position pendant switch to (L) “LIFT” and press the “UP” portion of the lower button.

NOTE: When raised to coach floor level, the bridgeplate assembly will automatically deploy across coach threshold gap.

Passenger Unloading (Normal Mode)

1. Unfasten both wheelchair and passenger restrains, and position wheelchair on lift platform.
2. Fasten the wheelchair restraint/interlock belt across the lap of wheelchair occupant.

NOTE: The lift will not function in the Up/Down mode until restraint/interlock is connected.

3. Position pendant switch to (L) “LIFT” and press the “DOWN” portion of the lower button.

NOTE: When lowered, the rollstop assembly will deploy by mechanical actuator assembly.

4. Unfasten restraint/interlock belt and allow wheelchair to leave platform, and manually raise the rollstop.
5. Refasten the wheelchair restraint/interlock for continued lift operation.
6. Position pendant switch to (S) “STOW” and press the “UP” portion of the lower button.
7. Proceed with steps #3 thru #7 of the previous “Lift Stowage” instructions.

NOTE: The handrails may also be lowered after step #4 of this procedure if desired.

Lift Deployed To Exit Coach (Manual Mode)

1. Proceed with steps #1 thru #7 of the previous “Lift Deploy (Normal Mode)” instructions.
2. Grasp the front of the platform and pull out firmly.

NOTE: Best results are attained by starting with a sharp tug followed by a constant pull until lift is extended against carriage stops.

3. Unbuckle restraint belt, and rise both handrail assemblies to the vertical (locked) position. After raising handrails reconnect the restraint/interlock belt for continued lift operation.
4. Open the #1 RH baggage door and gain entry into the lift control box.

NOTE: Make sure hand pump release valve is closed before starting the manual pumping operation.

5. Insert handle into the hand pump and begin steady pumping action.
6. Raise the platform to vehicle floor level.

NOTE: Do not raise the platform more than 1-1/2 inches above the coach floor level, as the wheelchair may have difficulty rolling over the bridgeplate incline.

Passenger Unloading (Manual Mode)

1. Assure that rollstop is in the reset (up) position
2. Proceed with steps #1 and #2 of the previous “Passenger Unloading” instructions.
3. Using the handle extension, slowly and steadily open the manual release valve. Leave release valve open until the platform reaches ground level and the rollstop opens completely.

NOTE: Do not open the release valve fully, as a sudden lift movement may cause wheelchair to lurch forward.

4. Proceed with steps #4 of the previous “Passenger Unloading” instructions.
5. Release handrail locks and fold handrails down onto platform by pulling up on the slamlock handle that secures handrail to platform skirt. After folding handrails, reattach the restraint/interlock.

Lift Stowage (Manual Mode)

1. Fully close the manual release valve.
2. Insert handle into the hand pump and begin steady pumping action.
3. Raise the lift platform to as near the exact stowing level.

NOTE: This level occurs and is evident when lifting frame arms are parallel to the side of lift enclosure cassette and platform.

4. With fingers up and palms forward, push the platform forcefully to start the lift moving inward. As the lift begins to move inward, maintain a constant pushing motion until the lift is completely inside the lift cassette.

In the unlikely event of a hydraulic system failure and the manual backup pump is inoperative, the lift may be stowed in the following manner.

⚠ CAUTION ⚠

It is recommended that two able-bodied persons be used in attempting to stow a disabled lift. The lift platform is heavy and should be lifted with care.

1. Prepare platform for stowing with the restraint/interlock belt unfastened and retracted and handrails in the folded position.
2. Grasp the platform at the front and lift the platform manually to as near the exact stowing level as possible.

3. Forcefully push the platform to start the lift moving inward. Maintain a constant pushing motion until the lift is completely inside the lift cassette

Safe Operation Tips

Safe operation of the wheelchair lift is of extreme importance. Unsafe or careless operation can result in injuries to passengers, lift operator or others in the vicinity of the lift. Damage to the lift can result from such operation. This general list of precautions should be followed when operating the wheelchair lift.

1. Wheelchair lift must be operated by trained personnel only.
2. Lift operation should not be attempted on unlevel or sloping areas. An eight (8) degree slope is the maximum angle at which the lift should be operated.
3. Before beginning wheelchair lift operations, determine that the area of ground below the lift is free of any debris or obstructions which would prevent the lift platform from being completely deployed.
4. Operate the wheelchair lift system pendant control buttons from a safe position, but retain a clear view of the lift area at all times.
5. While parking the operator should ensure that wheelchair lift door will not be blocked by trees, posts or other obstacles when opened. Also make certain the door opening area is clear of pedestrians or waiting wheelchair passengers.
6. Never leave the pendant control assembly unattended while controls are unlocked and energized.
7. Operate the wheelchair lift through a complete up or down cycle for maximum passenger comfort. Do not suddenly reverse the direction of lift travel.
8. Make certain the wheelchair passenger engages the brake on the wheelchair after he is properly situated on the lift platform. The brake should remain on during the lifting or lowering cycle, and during coach travel.
9. The wheelchair should be safely inboard of rollstop and its occupant should have his hands close to himself while on the lift platform.
10. Check that the ramp area is safe and level for boarding of the wheelchair passenger.
11. Do not use the manual mode for boarding passengers.
12. The operator should keep his hands and feet clear of the lift door and lift landing area when operating the wheelchair lift in the manual mode.
13. Electric wheelchairs should be loaded and unloaded manually.
14. Do not exceed the maximum 660 lb. (300 kg.) operating load limit of the lift.
15. When raising or lowering the lift with a passenger, the bridgeplate and rollstop barriers must be in the upright position and locked.

MAINTENANCE

The following preventive maintenance procedures are designed to meet the needs of a normal operating environment. Operating in extremely dirty and dusty environment or frequent use of the wheelchair lift system will require a more intense maintenance schedule.

LUBRICATION

The following items require periodic lubrication per the intervals and specifications listed:

Every three (3) months the drive chains, bridgeplate assembly and rollstop assembly should be spray lubricated with Curtisol Red Grease #88167. Remove any excess grease from the assemblies.

Check the hydraulic oil level in the reservoir every three (3) months. The reservoir should be filled to the “FULL” line at rear of reservoir with lift at stow position. Texaco #15 aircraft hydraulic fluid is recommended. Every year the reservoir should be emptied and refilled with new fluid.

Every year the cam followers and slam-lock handrail latches should be greased with Chevron SR-1 Multi-Purpose grease. Remove any excess grease from the cam followers and surrounding areas.

NOTE: After washing the lift always re-lubricate the above mentioned items.

INSPECTIONS OR CHECKS

Daily Interval

1. With lift in the stowed position, ensure that all lift support points are fastened properly, and carriage stops are tight and undamaged.
2. With lift completely extended out of cassette, ensure that all warning and instructional labels are in place and legible.
3. As lift is extended, listen for any abnormal sounds. Ensure that clutch makes the familiar clicking sound at full extension, and that platform stops squarely at stops.
4. Note that carriage, lifting frame and platform pivot pins are secure and undamaged. Ensure that the lift cylinder pivot pins are secure and undamaged, and that all cotter pins are engaged and secure.
5. Ensure that all carriage, lifting frame and platform welds are in proper order, and that all platform mounting brackets are properly fastened to both sides of platform.
6. Make sure that both handrails pivot properly and that they securely and tightly lock in place, and that the restraint/interlock belt works properly.

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7. With the lift raised to floor level, note that the bridgeplate functions properly and that the lift stops at the correct level. Make sure that the pneumatic spring snap rings are present and seated.

8. With lift lowered to ground level, assure that the rollstop deploys and closes properly and that return springs are in order.

9. Bring lift to stow level and determine if lift seeks proper level. Stow lift into cassette and listen for the clicking sound from clutch.

Bi-Weekly Interval

1. Check cassette slide channels for any obstructions or debris.

Three Month Interval

1. Check and adjust limit switch levels for stow mode.

NOTE: The wheelchair lift assembly should have all final adjustments made at the time of delivery. However, over a period of time some adjustment to the vertical travel limit switches may be required (Figure 10). Refer to the Ricon Service Manual for all final adjustment procedures.

2. Lubricate the drive chains, bridgeplate assembly and rollstop assembly

3. Check the hydraulic oil level in the pump reservoir.

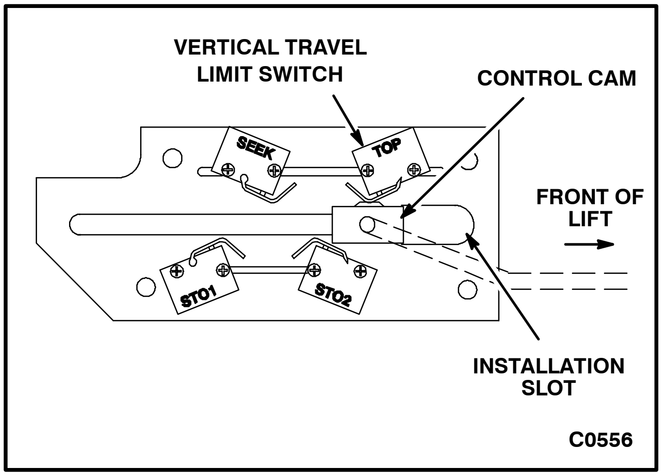

Figure 10. Cam Follower Adjustment

Yearly Interval

1. Inspect that torque limit clutch operates within tolerances.

2. Grease cam followers and handrail latches.

3. Drain and refill pump reservoir with new fluid.

4. Check drive chain tension, and torque clutch attachment hardware.

5. Check drive spur gear attachment hardware.

6. Inspect the complete hydraulic circuit for any leakage, and check hose for wear.

Seven Year Interval

1. Replace all pendant control assembly switches..

2. Replace pump motor brushes.

NOTE: During the above periodic maintenance procedures the manual mode of operation should be checked for proper operation.

⚠ WARNING ⚠

After ten years of service, it is recommended that the lift assembly be completely refit.

⚠ CAUTION ⚠

Prior to beginning any major lift system repair procedures, carefully read the applicable service procedure as shown in the Ricon Service Manual.

SAFETY PRECAUTIONS

1. Never adjust or lubricate the wheelchair lift while it is moving.

2. Always lower the platform when servicing the wheelchair lift system.

3. Always support platform extension with safety stands when working underneath the platform.

⚠ WARNING ⚠

Before disconnecting any hydraulic lines, properly support lift or lower it to ground.

4. Ensure all covers are in place after servicing components.

INSTRUCTIONAL DECALS

Decals pertaining to wheelchair lift operation, maintenance, and safety are at various interior and exterior coach locations. It is important to keep these decals legible. Replace decals if destroyed, missing, painted over or illegible.

To keep decals clean, remove dirt with a damp cloth. Use a mild nonabrasive detergent to remove grease. Do not use solvents on decals; this can damage or destroy the decal.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
LIFT DOES NOT DEPLOY WHEN THE “OUT“ BUTTON IS PRESSED. LIFT MAKES NO NOISE.	Vehicle safety interlock not engaged or failure. Lift not in stow mode or mode switch failure. One of three circuit breaker tripped.	Engage interlock or verify operation of the interlock circuit. Move mode witch to the “STOW (S) position. Replace switch. Check circuit breakers.
LIFT DOES NOT DEPLOY WHEN THE “OUT“ BUTTON IS PRESSED. LIFT MAKES A CONTINUOUS “CLICKING” OR “KNOCKING” NOISE.	Lift was previously stowed too high within the cassette. Torque limit clutch too loose.	Open manual release valve and lower lift while still inside cassette. Adjust torque limit clutch.
LIFT DOES NOT LOWER WHEN THE “DOWN” BUTTON IS PRESSED.	Lift is not fully deployed. Lift not in lift (L) mode or “UP/DOWN” switch failure. Down solenoid valve failure.	Deploy lift fully. Move mode switch to the “LIFT“ (L) position. Replace switch. Replace solenoid valve.
LIFT DOES NOT LOWER MANUALLY	Obstruction of flow control valve.	Clean valve and flush hydraulic system.
LIFT DOES NOT RAISE WHEN THE “UP” BUTTON IS PRESSED. LIFT MAKES NO NOISE	Lift is not fully deployed. TOP limit switch or “UP/DOWN” switch failure. Hydraulic pump motor failure.	Deploy lift fully. Adjust or replace switches. Replace pump motor.
LIFT DOES NOT RAISE WHEN THE “UP” BUTTON IS PRESSED. PUMP MOTOR SPIN NOISE IS EVIDENT.	Manual release valve is open. Hydraulic or manual pump failure. Down solenoid valve failure.	Close release valve. Replace or repair pump. Replace solenoid valve
LIFT IMMEDIATELY STARTS TO LOWER AFTER “UP” BUTTON IS RELEASED. PUMP MOTOR SPIN NOISE IS EVIDENT.	Manual release valve is partially open. Manual pump failure. Down solenoid valve failure.	Close release valve. Replace or repair pump. Replace solenoid valve
LIFT DOES NOT STOW WHEN “IN” BUTTON IS PRESSED. LIFT MAKES NO NOISE.	Lift not in stow mode or mode switch failure. In or Out relay failure.	Move mode witch to the “STOW (S) position. Replace switch. Replace relay.
LIFT ATTEMPTS TO STOW TOO LOW WHEN THE “IN” BUTTON IS PRESSED.	Auto-level relay failure. TOP, STO1 or STO2 limit switch out of adjustment or failed. Hydraulic pump motor failure.	Replace relay. Adjust or replace limit switch. Replace pump motor.
LIFT ATTEMPTS TO STOW TOO HIGH WHEN THE “IN” BUTTON IS PRESSED.	Auto-level relay failure. STO1 or STO2 limit switch out of adjustment or failed. Down solenoid valve failure.	Replace relay. Adjust or replace limit switch. Replace solenoid valve.

TROUBLESHOOTING (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
LIFT DOES NOT STOW WHEN "IN" BUTTON IS PRESSED. LIFT MAKES A CONTINUOUS "CLICKING" OR "KNOCKING" NOISE.	Lift not stowing at proper level. Torque limit clutch too loose.	Recheck final adjustment and operation. Readjust the torque limit clutch.
LIFT OSCILLATES VERTICALLY WHILE ATTEMPTING TO STOW.	SEEK, STO1 or STO2 limit switch out of adjustment or failed.	Adjust or replace limit switch.

NOTE: REFER TO THE RICON SERVICE MANUAL FOR ALTERNATE SYMPTOMS, CAUSES AND REMEDIES.

SEATING AND RESTRAINT SYSTEMS

GENERAL DESCRIPTION

To provide wheelchair parking space on the Left or Right hand side of the coach, special sliding and folding seats have been installed. These seats can be folded and moved forward as far as their floor and sidewall tracks will allow. A single pedestal slider seat is provided on the left-hand side of coach, while the right-hand side has a dual pedestal seat.

OPERATION

SEAT CONVERSION

Because two different styles of seating are used, there will be separate converting instructions. The following procedures are used when performing this function.

Dual-Pedestal Seat (Right Hand Area)

1. Release the seat back (1) to the upright position.

2. Raise the seat bottoms to a vertical position (Figure 11).

3. Pull locking pin (2) in the pedestal to release the pedestal lock.

4. Pull the pedestal lock (3) up to release the sliding seat pedestal.

5. At the slider assembly in the seat's wall track, push the lever (4) down to release the sliding assembly.

6. Push the seat forward to its storage position.

7. Push down on the foot lever (3) and pull up on the wall lever (4) to lock the seat in position.

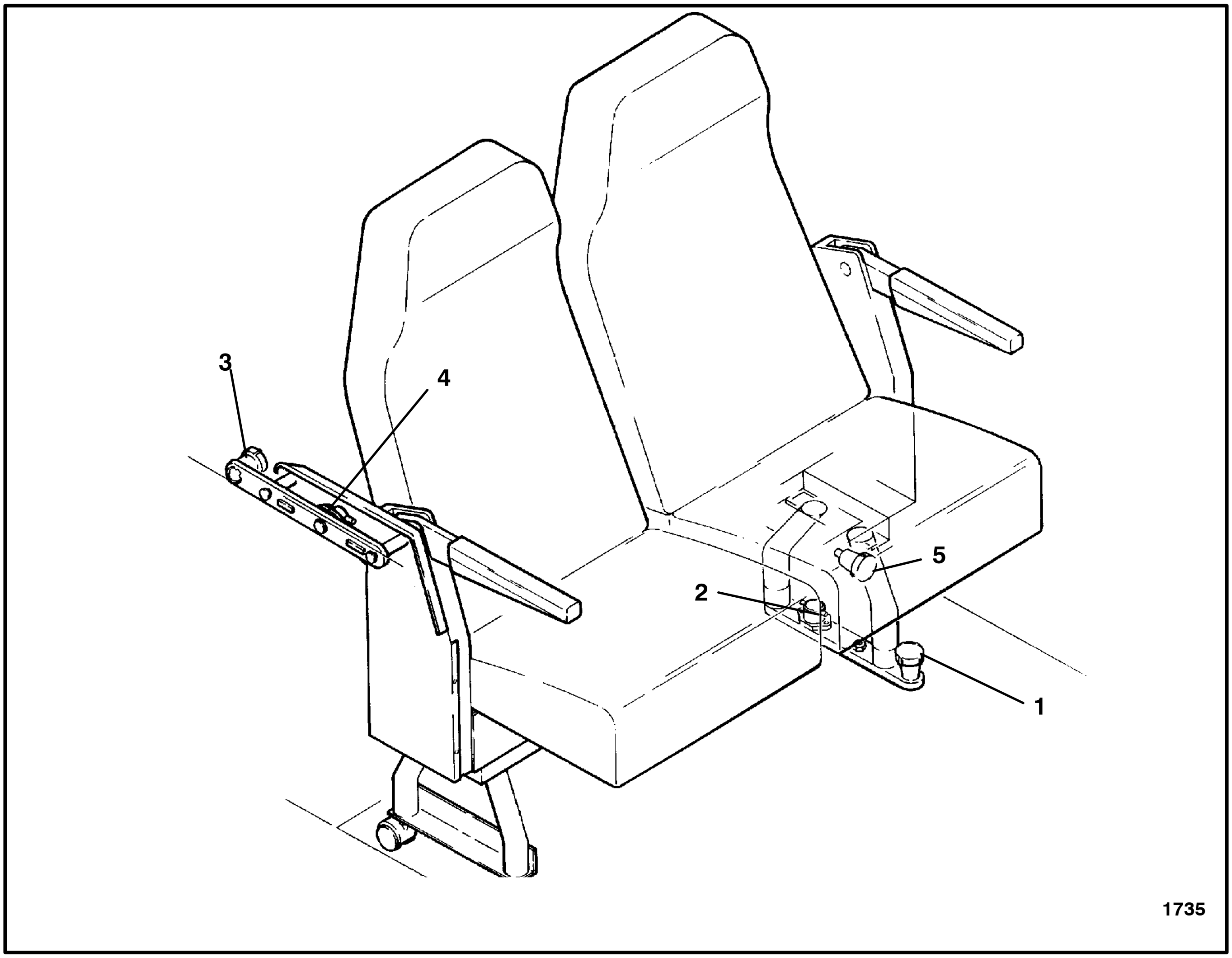

Figure 11. Sliding/Folding Seat (Right–Hand Shown)

8. Reverse this procedure to return seat to regular service.

Single-Pedestal Seats (Left Hand Area)

1. Release the seat back (1) to the upright position.
2. Raise the seat bottoms to a vertical position and secure with prop rod.

NOTE: This step releases the sidewall index plunger pin lock.

3. Pull forward and up on latch in the pedestal to release the pedestal lock.
4. Push the seat forward to its storage position.
5. Push down and rearward on the pedestal lever to lock the seat in position.
6. Reverse this procedure to return seat to regular service.

Seat Adjustments

If the seat does not lock tight enough, the clamping force can be adjusted by the jamnut (5) and resetting the clamping foot. With the pedestal locked in position, check the pedestal to floor clearance to ensure it is 0.063 inch. If the clearance is not 0.063 inch, loosen the jamnut (5) and turn the adjusting nut up or down until 0.063 inch is obtained. Retighten the jamnut.

To reset the clamping force on the wall slider assembly, loosen the jamnut (5) and turn the adjustment in or out until the proper force has been achieved.

RESTRAINTS

NOTE: Restraint belts are retracted into the floor and post cap assembly spools. Front Wheelchair belts are stowed in the parcel rack.

Wheelchair

1. Center the wheelchair between the four floor plates and move it forward to access the rear floor retractors (Figure 12).
2. Loop the rear wheelchair belting system (red) around the rear corners of the wheelchair and buckle it to the other retractor tongue (key #2).

NOTE: If belt is not long enough, it can be extended with the retractor release lever.

3. Move wheelchair to the rear and lock wheels.

NOTE: Take up any slack with the retractor release lever.

4. Attach the front retractors to each of the floor mounting plates, by lifting up on lever and inserting into floor mount and then locking lever (key #1).
5. Push down on retractor release lever and extend belts and loop around front corners of wheelchair and buckle.

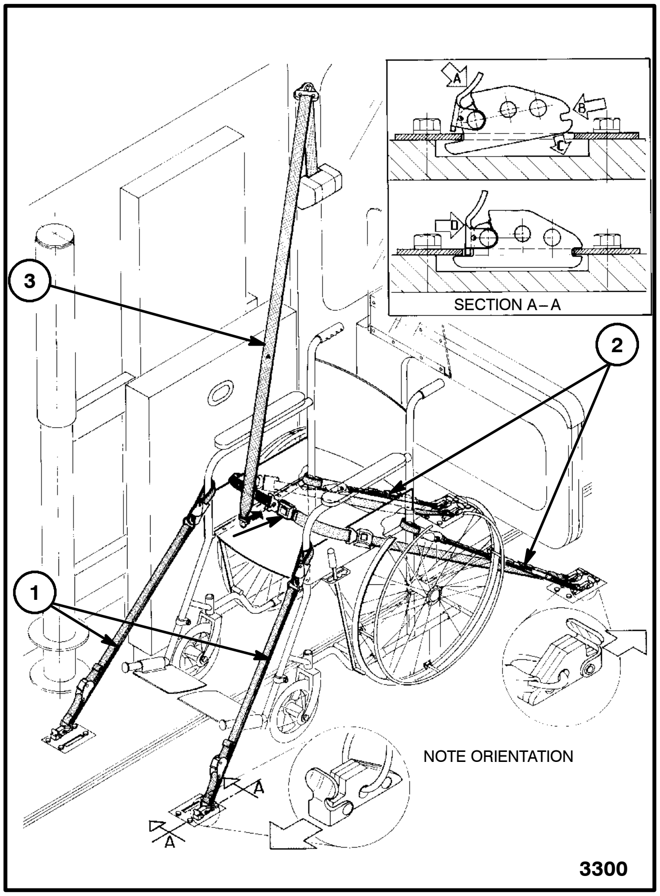

Figure 12. Wheelchair Restraint System

6. Push down on retractor release to take up any slack in the belts.
7. Pull repeatedly on the black lever of the retractor to tighten belts.

Occupant

1. Place the lap belt system (black) around the passenger and buckle to other retractor belt.

NOTE: Keep the lap belt as close as possible to the passenger’s hips.

2. Attach the shoulder restraint to the lap belt assembly (key #3).
3. Remove the slack from the lap and shoulder belts by retractor releasing lever.

LIFT COMPARTMENT AND ACCESS DOOR

GENERAL DESCRIPTION

The lift compartment and wheelchair access doors seal the interior of the baggage bay and passenger compartments from weather and unauthorized access. Both doors are positively locked by a latching mechanism similar to that used on the basic baggage compartment doors. The latch is operated by pulling the door handle. Both doors swing out to open and are keep fully open by their respective door prop devices.

MAINTENANCE

INSPECTIONS OR CHECKS

Daily Interval

1. Check the wheelchair lift entrance light daily. Replace burned out bulbs immediately. The replacement bulbs for these lights are listed in the specifications portion of this supplement.

Six Month Interval

1. Check the door alignment and adjust if necessary.
2. Remove the ABS panel and lubricate the door catch shaft pillow blocks (2). Replace ABS panel.
3. Lubricate the door hinges with a spray type lubricant.
4. Confirm the presence of all door latching hardware.
5. Inspect all moving parts of the door for signs of excessive wear. Check suspect areas more frequently and service any components that are worn or damaged.

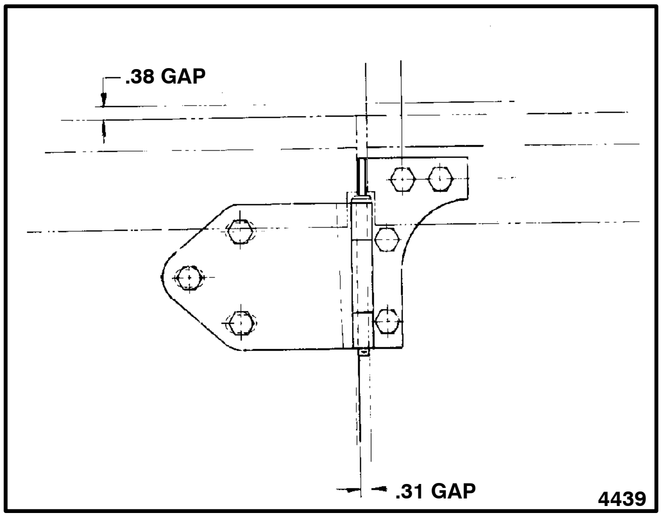

Figure 13. Lift Door Clearances (Top)

DOOR ADJUSTMENTS

1. The lift door should first be adjusted to fit the door opening in the coach frame and checked for proper sealing. Refer to the dimensions shown (Figures 13 and 14).
2. Mount the lift door using the dimensions shown (Figures 13 & 14).
3. After the lift door has been mounted, it can be adjusted up and down with the bolts on the coach body. Left and right adjustment with the bolts on the door.

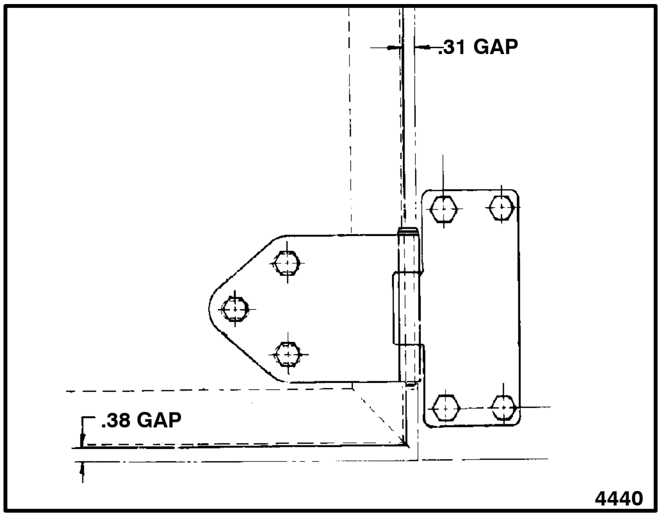

Figure 14. Lift Door Clearances (Bottom)

4. From inside the coach and check the door seals for proper sealing contact.
5. If the door locks too tightly (pinches the seal) or too loosely, adjust the door catches in or out to attain a proper seal.
6. Adjust the door control lever travel to obtain a firm over-center lock.

Adjust the door interlock switch so that it is fully activated in the closed position. Note that the mounting bracket for the door switch may be adjusted.

SPECIFICATIONS

LIFT ASSEMBLY

Manufacturer	RICON CORPORATION
Model Number	F9000
Voltage	24-Volt
Part Number	22L-1-330

WHEELCHAIR RESTRAINTS

Part Number	3L-18-522 (AMERICAN SEATING)
Part Number	3L-18-797 (NATIONAL SEATING)

LIFT COMPARTMENT & ACCESS DOORS

Part Number (Access Door)	3L-32-575-0001
Part Number (Lift Compartment Door)	3L-29-538

ACCESS DOOR HEADER LAMP

Part Number	7K-8-560

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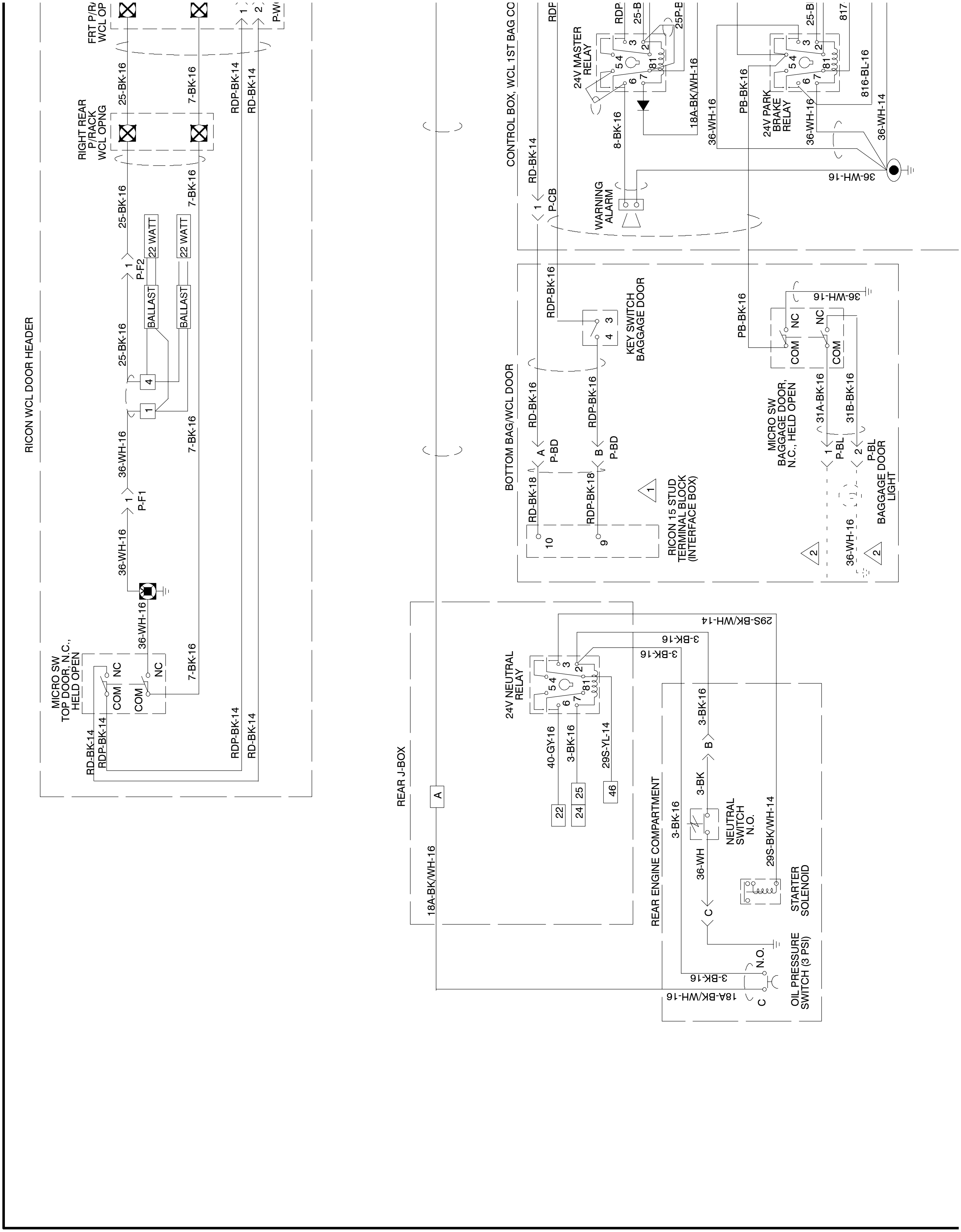
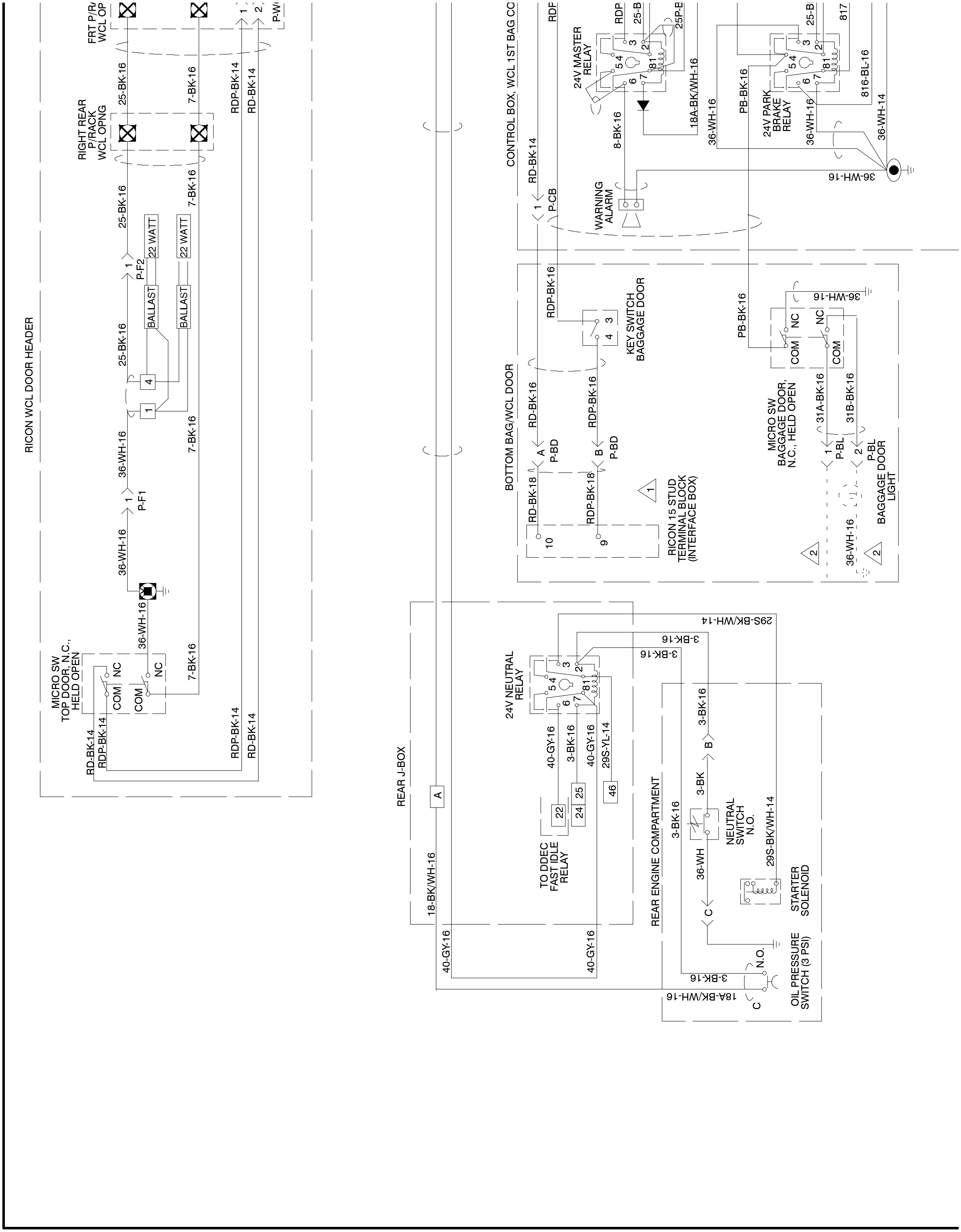


RICON WCL DOOR HEADER
RIGHT REAR P/RACK WCL OPNG
FRT P/R
WCL OP
25-BK-16
7-BK-16
RDP-BK14
RD-BK14
P-W
1
2
P-F2
22 WATT
BALLAST
4
1
36-WH-16
P-F1
MICRO SW TOP DOOR, N.C., HELD OPEN
NC
COM
RD-BK-14
RDP-BK-14
REAR J-BOX
A
18A-BK/WH-16
24V NEUTRAL RELAY
3
2
5
4
8
1
6
7
40-GY-16
3-BK-16
29S-YL-14
22
24
25
46
29S-BK/WH-14
3-BK-16
REAR ENGINE COMPARTMENT
B
3-BK
NEUTRAL SWITCH N.O.
36-WH
C
STARTER SOLENOID
N.O.
OIL PRESSURE SWITCH (3 PSI)
BOTTOM BAG/WCL DOOR
RD-BK-18
RDP-BK-18
10
9
RICON 15 STUD TERMINAL BLOCK (INTERFACE BOX)
P-BD
RD-BK-16
RDP-BK-16
KEY SWITCH BAGGAGE DOOR
3
4
PB-BK-16
MICRO SW BAGGAGE DOOR, N.C., HELD OPEN
31A-BK-16
31B-BK-16
P-BL
BAGGAGE DOOR LIGHT
36-WH-16
2
CONTROL BOX, WCL 1ST BAG CO
RDF
RDP
25-B
25P-B
24V MASTER RELAY
8-BK-16
18A-BK/WH-16
WARNING ALARM
P-CB
36-WH-16
24V PARK BRAKE RELAY
816-BL-16
817
36-WH-14


RICON WCL DOOR HEADER
MICRO SW TOP DOOR, N.C., HELD OPEN
COM
NC
RD-BK-14
RDP-BK-14
36-WH-16
7-BK-16
36-WH-16
1
P-F1
36-WH-16
1
4
25-BK-16
7-BK-16
BALLAST
BALLAST
22 WATT
22 WATT
1
P-F2
25-BK-16
7-BK-16
RIGHT REAR P/RACK WCL OPNG
25-BK-16
7-BK-16
FRT P/R WCL OP
RDP-BK-14
RD-BK-14
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P-W
REAR J-BOX
A
18-BK/WH-16
40-GY-16
TO DDEC FAST IDLE RELAY
22
24
25
46
40-GY-16
3-BK-16
40-GY-16
29S-YL-14
24V NEUTRAL RELAY
3
2
5 4
81
6
7
29S-BK/WH-14
3-BK-16
3-BK-16
REAR ENGINE COMPARTMENT
3-BK-16
B
3-BK
3-BK-16
NEUTRAL SWITCH N.O.
36-WH
C
29S-BK/WH-14
STARTER SOLENOID
N.O.
C
3-BK-16
18A-BK/WH-16
OIL PRESSURE SWITCH (3 PSI)
BOTTOM BAG/WCL DOOR
RD-BK-18
RDP-BK-18
10
9
RICON 15 STUD TERMINAL BLOCK (INTERFACE BOX)
1
A
P-BD
B
P-BD
RD-BK-16
RDP-BK-16
KEY SWITCH BAGGAGE DOOR
4
3
RDP-BK-16
2
2
36-WH-16
1
P-BL
2
P-BL
BAGGAGE DOOR LIGHT
31A-BK-16
31B-BK-16
MICRO SW BAGGAGE DOOR, N.C., HELD OPEN
COM
NC
COM
NC
PB-BK-16
36-WH-16
CONTROL BOX, WCL 1ST BAG CO
RD-BK-14
1
P-CB
RDF
WARNING ALARM
8-BK-16
24V MASTER RELAY
RDP
25-B
25P-B
3
2
5 4
81
6
7
18A-BK/WH-16
36-WH-16
36-WH-16
PB-BK-16
24V PARK BRAKE RELAY
25-B
817
816-BL-16
36-WH-16
36-WH-14

102D SERIES
STEWART & STEVENSON WHEELCHAIR LIFT MAINTENANCE MANUAL SUPPLEMENT
P/N 3L-15-1573A JANUARY, 1997

This Supplement is used in conjunction with the 102D Series Maintenance Manual. When servicing a Stewart & Stevenson wheelchair lift equipped coach, refer to this supplement first to identify any specialized wheelchair coach information. If the information you seek is not in the supplement, please refer to the basic manual.

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LIFT ASSEMBLY

GENERAL DESCRIPTION

Coaches fitted with the Stewart and Stevenson Powerlift™ wheelchair lift have the capabilities of safely onloading, securing for travel and offloading two (2) wheelchair passengers in addition to their normal passenger compliment. The lift module is located approximately midway along the coach's right hand side, whereby, it can easily be access from the sidewalk. The lift utilizes an electrically operated and controlled hydraulic system to perform normal loading and unloading functions, and features an additional emergency manual back-up system.

The module is fitted to the coach just inside the wheelchair door area, and is securely bolted to coach framework. The wheelchair lift assembly operates within the area above the #2 RH baggage compartment (Figure 1).

Coach access for wheelchair passengers is through a hinged, outward opening, self-locking sidewall door. The door extends from the passenger compartment floor level to the roof, and when opened, allows for the lift module to be swung out and deployed for operation. The door features keyed access, and incorporates a safety interlock switch to assure positive closure. When opened to its maximum (approximately 90 degrees), the door should automatically self-lock to avoid interference with lift operation.

Two spaces are provided to securely retain wheelchair passengers while traveling. The first space is located next to the lift platform, with another located directly across the aisle from the lift. Special seats that fold and slide away on tracks are located in the left-hand wheelchair parking area. By repositioning these seats, space for an additional wheelchair occupant is provided. Four (4) restraining straps securely attached to floor clamps retain wheelchair during travel, along with a passenger lap belt and an interconnecting shoulder harness (Figure 2). Special floor covering on the lift platform and in wheelchair parking areas provides proper traction for the wheelchairs.

The lift platform, barriers, inner and outer handrails, drive and guide mechanisms and support column of the lift are factory assembled into a space saving modular unit (Figure 3). Other components of the lifting system including the electrically operated pump, emergency hand pump and fluid reservoir are located inside a control box mounted to the rear of the front right hand baggage compartment (Figure 4).

COMPONENTS

WHEELCHAIR MODULE COMPONENTS

Lift Structure

The lift structure contains the hydraulic lift cylinder, guide frame and counterbalance mechanism of the module. Additionally, it supports the hinged platform with outer handrail and barriers, and the inner handrail. The structure's outer panel has the lift switch and push bottom control mounted to it.

Support Column

The lift structure is supported by and welded to the column. The column's indexing base allows the lift structure to pivot out for deployment and in for stowing. The support column is mechanically connected by bolts to the coach framework, and can easily be unfastened for removal.

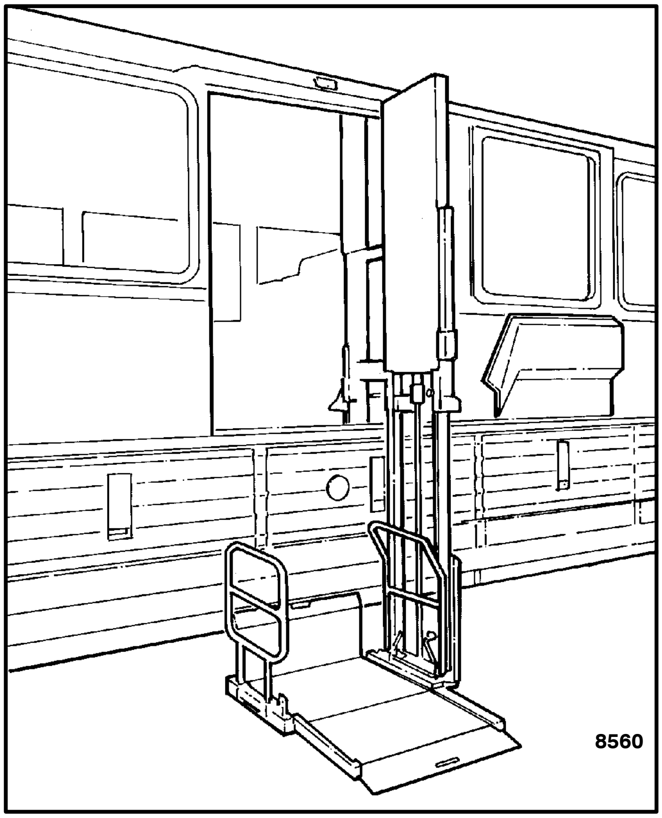


Figure 1. Wheelchair Lift Installation

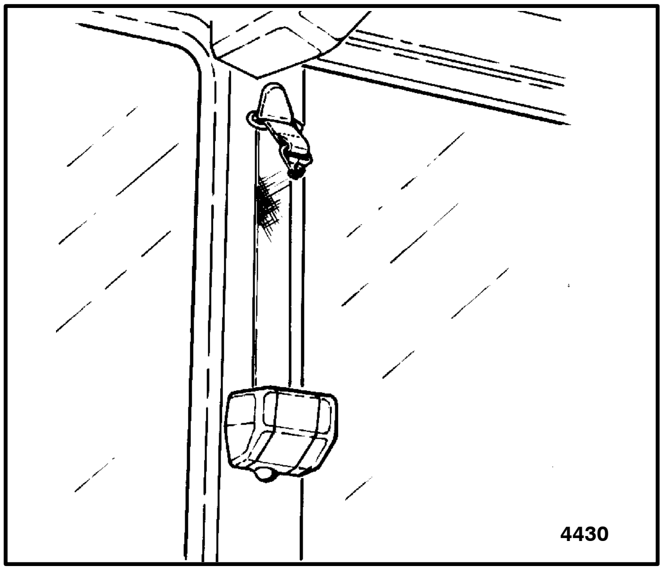


Figure 2. Wheelchair Passenger Restraint

Lift Platform

The lift platform supports the wheelchair while lift is in motion. The platform consists of a main section with rear barrier, and front hinged section with ramp/barrier. The platform is also hinged to the lift structure, and features a latching mechanism for retaining it in stowed position .

CONTROL BOX COMPONENTS

Power Unit

The power unit consists of an electric motor coupled to a hydraulic pump. The pump and motor are mounted to an electrically piloted solenoid controlled manifold, and actuated by the push button control switch that routes fluid to the lift's cylinder posts. The pump is supplied by the attached four quart reservoir.

Manual Release Valve

The valve is located on the bottom of the hydraulic hand pump, and controls the lift's emergency functions .

Emergency Hand Pump (Hydraulic)

The hand pump is located in the control box, and is piped into the lift system's hydraulic circuit for use in emergency situations.

ELECTRICAL COMPONENTS

Wheelchair Master Switch

The keyed switch located on the upper left-hand instrument panel. When activated, the park brake/fast idle and lift door interlock, lift switch, warning beeper, hazard light and lift interior header light circuits are energized.

Push Button Switch Assembly

The push button switch assembly controls the up/down movements of the lift's power unit. The switch is a momentary on type, and mounted on the lower left hand side of the outer lift structure panel.

Lift Switch

A secondary lift switch must be activated to energize the push button switch assembly. The wheelchair master switch key is also used for the lift switch.

Lift Door Interlock Switch

A lift door interlock microswitch, wired through the park brake interlock circuit, keeps park brake engaged until the lift door has been properly closed. The switch is located in the upper left-hand corner of the door frame .

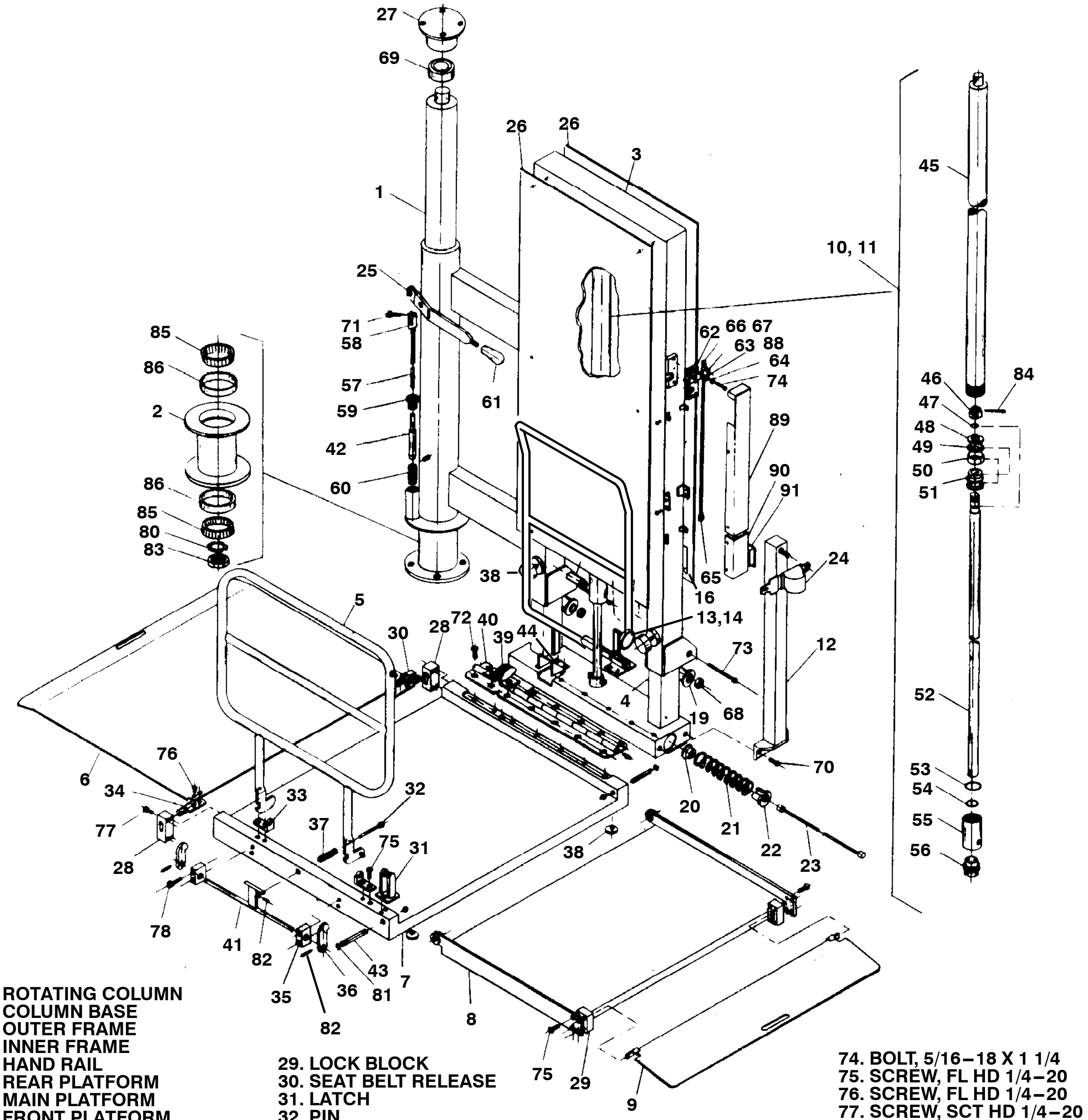
OPERATION

The wheelchair lift can be operated in two basically different ways. Normal operation utilizes the push button control assembly and is used when routinely embarking and disembarking wheelchair passengers. When the wheelchair lift is operated by the push button controls assembly, signals are sent from a switch to the solenoid valves which control the flow of the pressurized hydraulic fluid to or from the lift cylinder. The push button control assembly must be energized through the key operated lift switch, in addition to the wheelchair lift master switch on the driver's instrument panel, before the lift system will operate.

In emergency situations the manual mode is used for removing wheelchair passengers from a disabled coach or if the lift system should malfunction. A hand-operated hydraulic pump is used in the manual mode to unload wheelchair passengers from a coach which has lost power or whose wheelchair lift system has malfunctioned.

During maintenance procedures the manual mode of operation is required to be used. The manual mode should never be used for boarding a wheelchair passenger.

Both the electrically controlled power unit pump and valves, and the manually operated hydraulic hand pump and release valve are located in the front right-hand baggage compartment's control box. All hydraulic hoses and electrical control harnesses are routed through the coach floor to baggage compartment. In both of the different modes of operation, the lift platform is set-up and stowed in the same manner.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1. ROTATING COLUMN
2. COLUMN BASE
3. OUTER FRAME
4. INNER FRAME
5. HAND RAIL
6. REAR PLATFORM
7. MAIN PLATFORM
8. FRONT PLATFORM
9. BARRIER
10. CYLINDER
11. SEAL KIT (ITEMS 47, 49, 50, 53, 54, & 56)
12. SEAT BELT STAND
13. CLAMP
14. CLAMP PAD
15. CONTROL HANDLE
16. PUSH BUTTON
18. FLOW VALVE
19. ROLLER
20. SPRING COLLAR
21. SPRING
22. CABLE COLLAR
23. CABLE
24. SEAT BELT
25. HANDLE
26. COVER
27. ROTATING CAP
28. LOCK BLOCK
29. LOCK BLOCK
30. SEAT BELT RELEASE
31. LATCH
32. PIN
33. BRACKET
34. PIVOT PIN
35. PIVOT BLOCK
36. LATCH
37. SPRING
38. BUMPER
39. PULLEY CABLE
40. HINGE
41. BELL CRANK
42. INDEX PIN
43. PIN
44. CABLE COVER
45. TUBE
46. CASTLE NUT, 5/8−16
47. ”O” RING
48. WASHER
49. POLYSEAL
50. WEAR RING
51. PISTON
52. ROD
53. ”O” RING
54. ”O” RING
55. ROD END
56. GLAND SEAL
57. ROD
58. CLEVIS
59. SPRING CAP
60. SPRING
61. HANDLE
62. LATCH
63. LEVER
64. WASHER, 5/16
65. ROD
66. BALL JOINT
67. NUT, 1/4−28
68. BEARING
69. BEARING
70. BOLT, 3/8−16X1 1/4
72. SCREW, FLAT
73. BOLT, 3/8−16 X 3
74. BOLT, 5/16−18 X 1 1/4
75. SCREW, FL HD 1/4−20
76. SCREW, FL HD 1/4−20
77. SCREW, SCT HD 1/4−20
78. SCREW, SCT HD 1/4−20
80. WASHER
81. SNAP RING
82. ROLL PIN 1/8 X 5/8
83. NUT, SPECIAL
84. COTTER PIN
85. BEARING CONE
86. BEARING CUP
87. GROMMET
88. SPACER
89. TOP COVER
90. BOTTOM COVER
91. RELEASE LATCH
92. ANTI SKID
93. INSTRUCTION PLATE
101. IDENTIFICATION PLATE
102. NAME PLATE, POWERLIFT
103. LABEL, LATCH RELEASE

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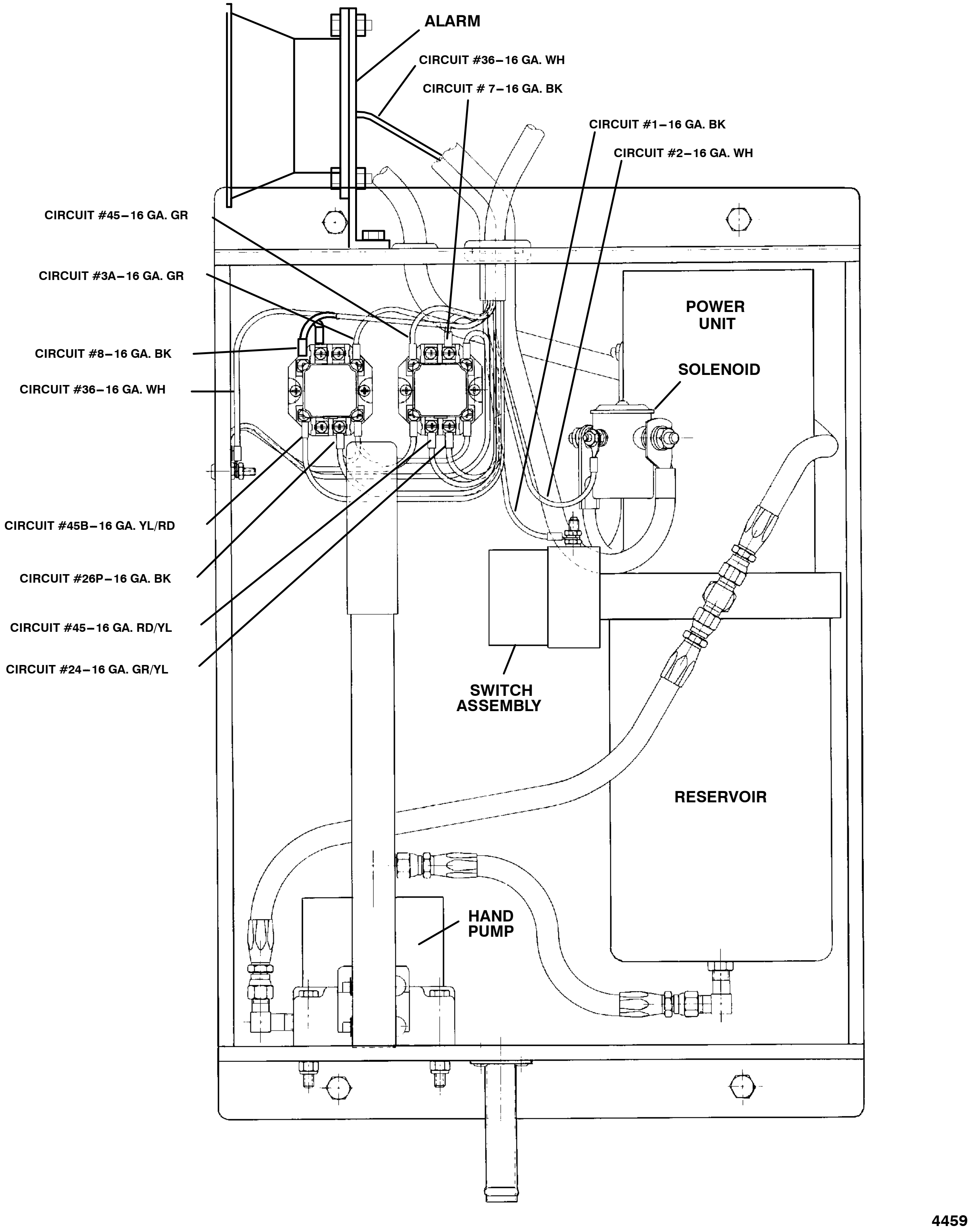
Figure 3. Lift Platform and Ramp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CIRCUIT # 7–16 GA. BK
CIRCUIT #1–16 GA. BK
CIRCUIT #2–16 GA. WH
CIRCUIT #45–16 GA. GR
CIRCUIT #3A–16 GA. GR
CIRCUIT #8–16 GA. BK
CIRCUIT #36–16 GA. WH
POWER UNIT
SOLENOID
CIRCUIT #45B–16 GA. YL/RD
CIRCUIT #26P–16 GA. BK
CIRCUIT #45–16 GA. RD/YL
CIRCUIT #24–16 GA. GR/YL
SWITCH ASSEMBLY
RESERVOIR
HAND PUMP
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Figure 4. Control Box in Front Right-Hand Baggage Compartment

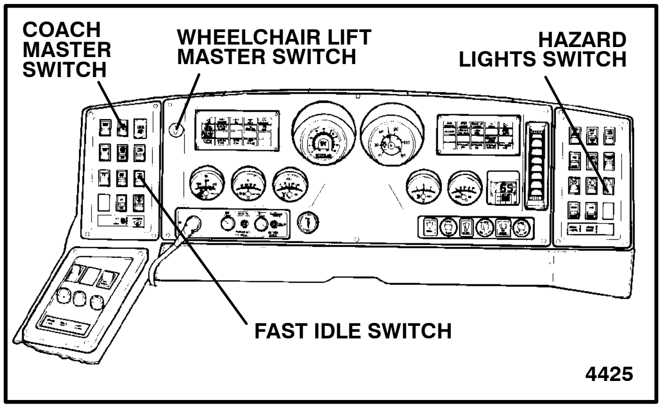

Figure 5. Wheelchair Lift Master Switch

LIFT OPERATING INSTRUCTIONS

All personnel charged with wheelchair lift operation must be trained, and know all the procedures for wheelchair lift's normal and emergency operation before operating the lift with passengers aboard.

⚠ WARNING ⚠

Follow the instructions carefully and in the order that they are given. Do not deviate from the sequence or try to eliminate any steps. Failure to do so may result in damage to the lift and/or passenger injury.

Passenger Loading (Normal Mode)

1. Stop the coach within two feet of the curb.
2. Shift the transmission to neutral and apply the park brake.
3. Turn the wheelchair lift system "ON" with the Wheelchair Lift Master Switch (Figure 6). This sends power to the key operated lift switch.
4. Remove the Wheelchair Lift System key and take spare ignition key to wheelchair lift door, unlock and open (Figure 6). Swing door through 90 degree arc until interior door locking rods are engaged in door channel.

NOTE: If there is not an extra ignition key, the engine must be shut down, the lift door unlocked, and engine restarted before performing step 3.

5. Energize the lift, by unlocking the lift switch with the master switch key (Figure 7).
6. Release the foot lock on the lift (Figures 8) by pulling back on the lever.
7. Disengage the column index pin by pulling down on the column lever (Figures 9), then swing the lift out of

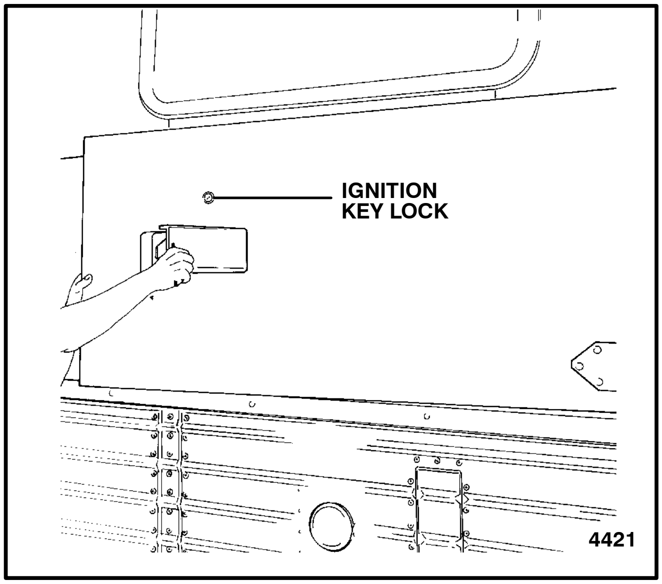

Figure 6. Lift Door Ignition Key Lock

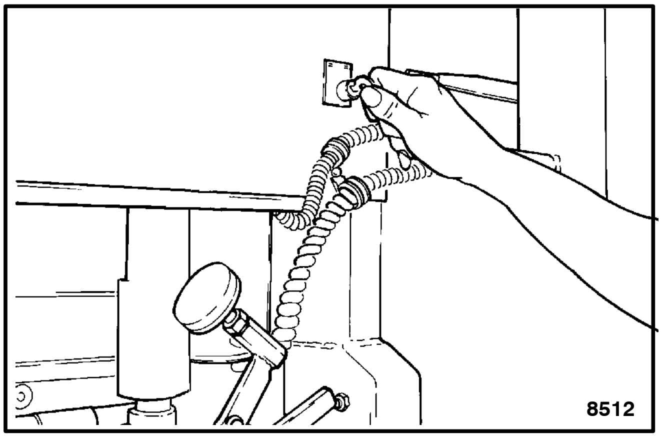

Figure 7. Lift Key Lock

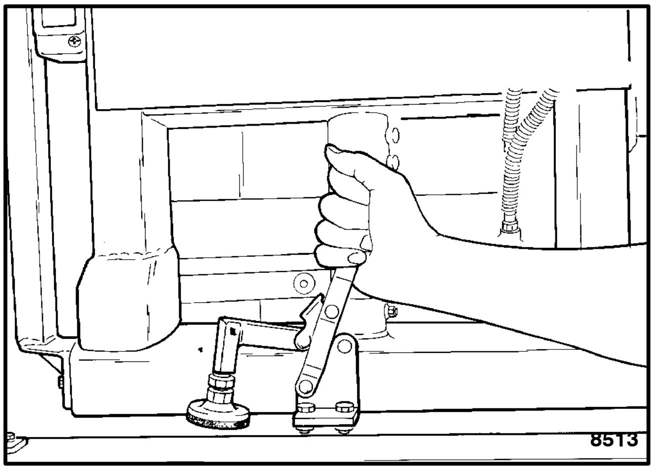

Figure 8. Lift Foot Lock

the coach until the index pin engages and locks the lift in the **"OPEN"** position.

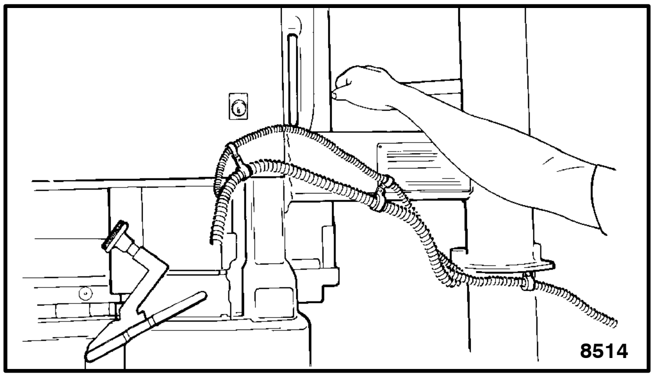

Figure 9. Lift Index Pin

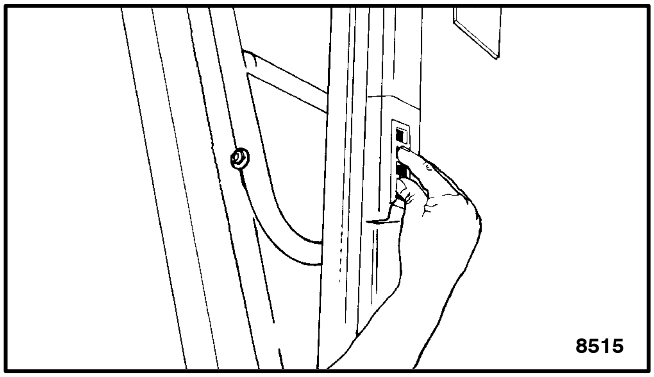

Figure 10. Platform Release Latch

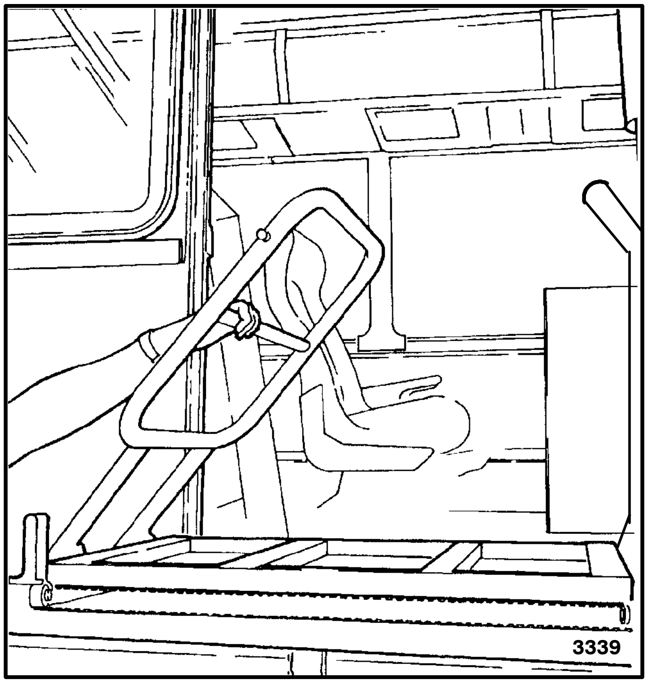

Figure 11. Wheelchair Lift Guard Rail

8. Remove the lift cover and hang on place provided on lift door.

9. Unlock and lower the counterbalanced platform by releasing the platform locking latch at front outer edge of lift structure (Figures 10).

10. Raise the outer guard rail to the upright locking position (Figure 11).

11. Unfold the front platform (Figure 12) and leave front barrier flat.

12. Raise the rear barrier to an upright position at rear of platform (Figure 13).

13. The lift may now be lowered by pushing the "DOWN" button on the panel mounted control assembly. Lift should gently lower to ground level.

14. Position wheelchair on lift platform.

NOTE: The passenger should always be loaded facing outward from the coach with the wheelchair centered on the main platform and the wheelchair brake set. Electric wheelchairs must be loaded and unloaded manually.

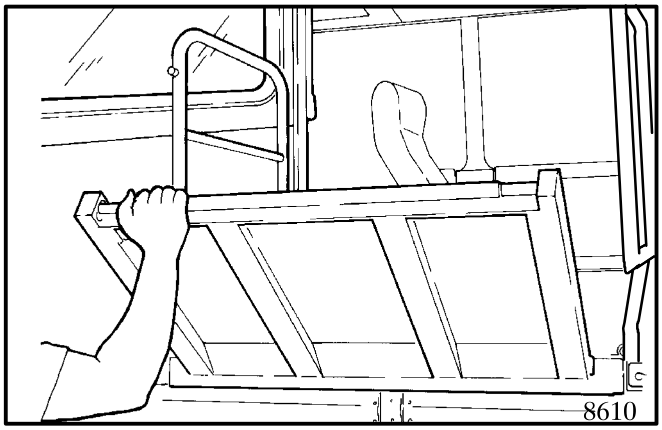

Figure 12. Front Platform

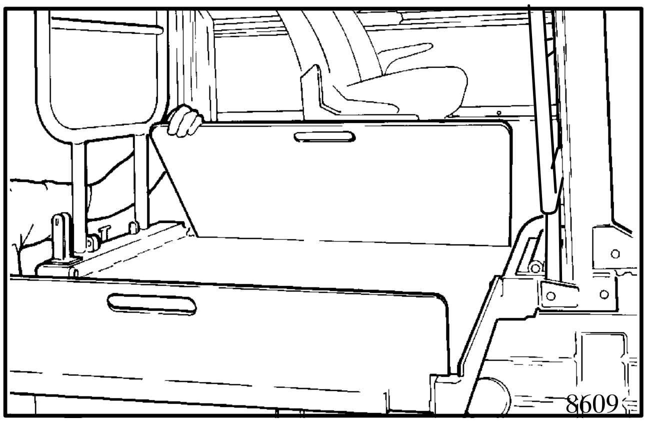

Figure 13. Rear Platform

15. Raise the front barrier and lock in position.

16. Fasten any wheelchair restraint belt to the guard rail and the passenger is ready to be lifted.

17. Push the "UP" button on the panel mounted control assembly, and raise the passenger to boarding height.

18. Position the rear barrier flat for passenger boarding.

19. To stow lift platform after passenger has boarded, fold the rear barrier down first, then fold the front barrier down onto the front platform. Lift and fold the front platform over onto the main platform.

20. Disengage the guard rail lock and fold the guard rail down.

21. Raise the entire counterbalanced lift platform and latch it firmly to the lift structure.

22. Replace lift cover over the stowed platform assembly.

23. Disengage the column index pin by pulling down on column lever, swing lift into the coach until index pin engages.

24. Set the footlock on the lift by pushing forward on the lever.

25. Turn lift switch "OFF" and remove key.

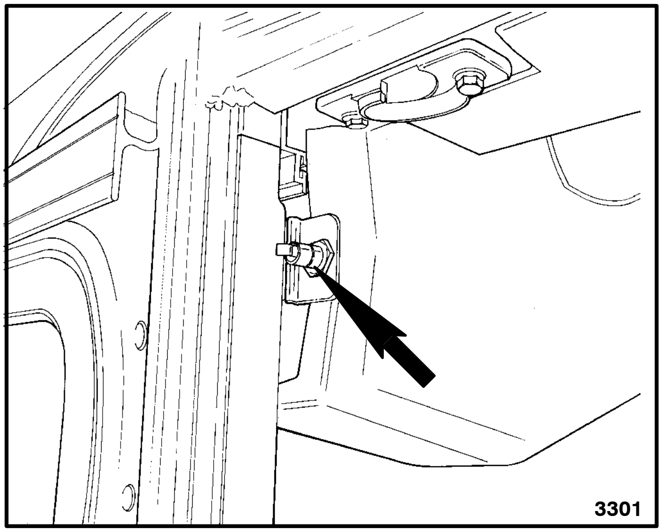

Figure 14. Lift Door Safety Interlock Switch

26. Lift door locking bar out of index hole on door channel and swing door closed.

27. Close and lock lift door. To assure the lift door is securely shut a safety interlock switch (Figure 14), located near the door header, is wired into the park brake interlock circuit.

28. Proceed to securing wheelchair passenger as described in "Restraints" later in this section.

Passenger Unloading (Normal Mode)

Proceed with steps #1 thru #10 of the passenger loading instructions.

1. Unfold the front platform section and lock front barrier up for boarding lift platform.

2. Position the rear barrier flat for boarding lift platform.

3. Release the wheelchair and occupant restraining straps, and position wheelchair on lift platform.

NOTE: The passenger should always be loaded facing outward from the coach with the wheelchair centered on the main platform and the wheelchair brake set. Electric wheelchairs must be loaded and unloaded manually.

4. Reposition the rear barrier to upright and lock in position for lowering.

5. Fasten any wheelchair restraint belt to the guard rail. The passenger is ready to be lowered.

6. The lift may now be lowered by pushing the "DOWN" button on the panel mounted control assembly.

7. After the lift makes contact with the ground, release button on control assembly.

8. Unfasten any wheelchair restraint belt from the guard rail, and passenger is ready to exit lift platform.

9. After passenger has been unloaded, push the "UP" button on the panel mounted control assembly, and raise lift platform to stow level.

Proceed with steps #19 thru #27 of the passenger loading instructions.

Passenger Unloading (Manual Mode)

1. Unlock and open lift door, making sure door locking rod is in place. Remove lift cover and stow.

2. Open the front right-hand baggage door.

3. Open the wheelchair lift control box.

4. Make sure hand pump release valve is closed.

5. Raise the lift slightly with the hand pump to assure that column will swing freely.

Proceed with steps #6 thru #10 of normal passenger loading instructions.

Proceed with steps #11 thru #15 of normal passenger unloading instructions.

6. Before opening valve and lowering lift, driver should safely position himself out of the way of lift's downward travel

7. Slowly open the valve on the back of the hand pump, and gently lower the lift platform to ground level.

8. After the passenger has exited platform, close the release valve on the back of the hand pump.

9. Raise the lift by pumping the hand pump until the lift reaches stowing height.

Proceed with steps #19 thru #27 of normal passenger loading instructions.

Raising Lift (Manual Mode)

CAUTION

Do not use the manual mode for loading passengers.

Proceed with steps #1 thru #4 and #19 of the manual passenger unloading instructions, and steps #19 thru #27 of the normal passenger loading instructions.

Safe Operation Tips

Safe operation of the wheelchair lift is of extreme importance. Unsafe or careless operation can result in injuries to passengers, lift operator or others in the vicinity of the lift. Damage to the lift can result from such operation. This list of precautions should be followed when operating the wheelchair lift.

1. Wheelchair lift MUST be operated by trained personnel ONLY.

2. Lift operation should not be attempted in extremely unlevel areas. An eight (8) degree slope is the maximum angle at which the lift should be operated.

3. Make sure the coach is fully stopped, that the transmission is in neutral, and the wheelchair lift master switch is turned “ON”.

NOTE: The park brake is engaged when the wheelchair lift master switch is turned “ON”.

4. Before beginning wheelchair lift operations, determine that the area of ground below the lift is free of any debris or obstructions which would prevent the lift platform from being completely deployed.

5. Operate the wheelchair lift system’s control buttons from a safe position, but retain a clear view of the lift area at all times.

6. While parking, the operator should ensure that wheelchair lift door will not be blocked by trees, posts or other obstacles when opened. Also make certain the door opening area is clear of pedestrians or waiting wheelchair passengers.

7. Never leave the control assembly’s push buttons unattended while controls are unlocked and energized.

8. Operate the wheelchair lift through a complete up or down cycle for maximum passenger comfort. Do not suddenly reverse the direction of lift travel.

9. Make certain the wheelchair passenger engages the brake on the wheelchair after he is properly situated on the lift platform. The brake should remain on during the lifting or lowering cycle, and during coach travel.

10. The wheelchair should be safely inboard of the gate and its occupant should have his hands close to himself while on the lift platform.

11. Check that the ramp area is safe for the ingress or egress of the wheelchair passenger.

12. DO NOT use the manual mode for boarding passengers.

13. The operator should keep his hands and feet clear of the lift door and lift landing area when operating the wheelchair lift in the manual mode.

14. Electric wheelchairs MUST be loaded and unloaded manually.

15. Do not exceed the MAXIMUM 750 lb. (340 kg.) operating load limit of the lift.

16. When raising or lowering the lift with a passenger, the barriers must be in the upright position and locked.

MAINTENANCE

The following preventive maintenance program is designed to meet the needs of a normal operating environment. Operating in extremely dirty and dusty environment or frequent use of the wheelchair lift system will require a more intense maintenance schedule.

NOTE: Prior to performing any maintenance procedure on the wheelchair lift, shut down coach engine and remove power from all lift systems.

All maintenance procedures should be performed at six month intervals or every one thousand (1000) cycle (whichever occurs first), unless otherwise specified. Any procedures that require the lift to be moved must be done in the manual mode. Operating in the manual mode is discussed earlier in this supplement.

The preventive maintenance information that follows is provided for the following parts of the wheelchair lift system.

LIFT STRUCTURE

The lift structure contains the hydraulic lift cylinder, guide frame and counterbalance mechanism of the module. Additionally, it supports the hinged platform with outer handrail and barriers, and the inner handrail. The structure’s outer panel has the lift switch and push bottom control mounted to it.

SUPPORT COLUMN

The lift structure is supported by and welded to the column. The column’s indexing base allows the lift structure to pivot out for deployment and in for stowing.

The support column is mechanically connected by bolts to the coach framework, and can easily be unfastened for removal.

LIFT PLATFORM

The lift platform supports the wheelchair while lift is in motion. The platform consists of a main section with rear barrier, and front hinged section with ramp/barrier. The platform is also hinged to the lift structure, and features a latching mechanism for retaining it in stowed position.

1. Visually inspect the hydraulic cylinder (10) and seal. Immediately replace the seal if fluid is leaking around it.
2. Inspect the power unit for leaks and test operation of the hand pump. Replace components that are not working properly.
3. Inspect all hydraulic hoses and connections. Replace damaged hoses immediately.
4. Confirm the presence of all hardware and replace as required.
5. Inspect all moving parts of the mechanism for signs of excessive wear or overloading. Check suspect areas more frequently and service any components that are worn or damaged.
6. Remove the main roller caps and visually inspect the main rollers for excessive wear or flat spots while operating the lift.
7. Inspect the inner frame tube for galling while operating the lift.
8. Visually inspect the main spring and cable for wear.
9. Visually inspect ramp slip resistant surface for signs of wear. Re-surface where required.
10. Inspect all pneumatic lines and electrical harnesses to ensure that they are properly secured and show no signs of wear. Replace or secure as required.
11. Check torques on all module fasteners. Tighten as required. Check for missing hardware and replace as required.

SPRING ADJUSTMENT

A counterbalance spring is incorporated into the wheelchair lift to assist in raising the platform to its stowed position (Figure 15). The spring tension has been set at the factory for proper tension. Should the spring fatigue over a period of time, the tension can be adjusted by:

1. Turning the bolt (1) clockwise in 1/8-inch increments. Two such adjustments can be made before spring replacement is required.

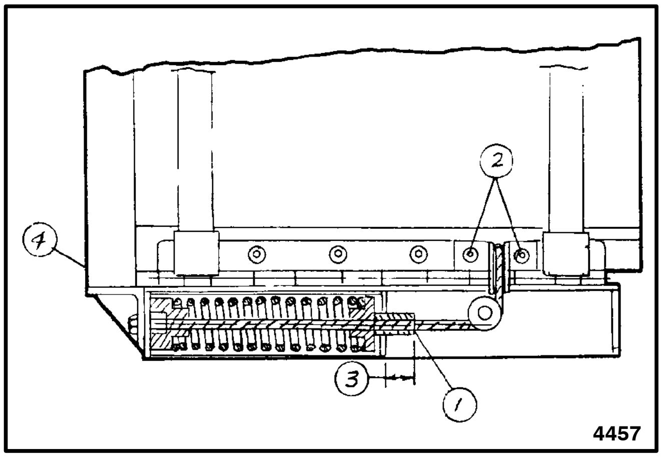

Figure 15. Spring Tension Adjusting Bolt

⚠ CAUTION ⚠

Over adjustment will stress the spring and the platform will not stow properly.

SPRING REPLACEMENT

1. Raise the platform to the stowed position.
2. Remove the seat belt post (4).
3. Back off the spring tension bolt (1) a distance of one inch (3).
4. Remove screws (2) and pull cable and spring out.
5. Insert cable and new spring into place. When installing spring be sure spring collars are in place.
6. Install cable around pulleys.
7. Install screws with antiseize and torque to 15 ft-lbs.
8. Bolt the seat belt post in place.
9. While the lift is still in the upright stowed position, adjust the spring tension bolt (1) to a dimension of approximately one inch (3).
10. Then lower the platform; the platform should have a 20 pound initial lift force. Adjust as necessary.

LUBRICATION

Grease the platform hinge at the lubrication point shown every 500 operating hours (Figure 16). Wipe off all excess grease from the fitting.

Check the hydraulic oil level in the reservoir every 50 operating hours. The reservoir should be full when the lift is at full extension (down) position. Do not add oil when the lift is in the stowed (up) position. ATF oil is recommended. DO NOT OVERFILL.

SAFETY PRECAUTIONS

1. Never adjust or lubricate the wheelchair lift while it is moving.

2. Always lower the platform when servicing the wheelchair lift system.

3. Always support ramp and ramp extension with safety stands when working underneath the platform.

⚠ WARNING ⚠

Before disconnecting any hydraulic lines, properly support lift or lower it to ground.

4. Ensure all covers are in place after servicing components.

INSTRUCTIONAL DECALS

Decals pertaining to wheelchair lift operation, maintenance, and safety are at various interior and exterior coach locations. It is important to keep these decals legible.

1. Keep decals clean. Remove dirt with a damp cloth. Use a mild, nonabrasive detergent to remove grease. Do not use solvents on decals; this can damage or destroy the decal.

2. Replace decals if destroyed, missing, painted over or illegible.

POWER UNIT

The power unit consists of an electric motor coupled to a hydraulic pump. The pump and motor are mounted to an electrically piloted solenoid controlled manifold, and actuated by the push button control switch, that routes fluid to the lift's actuating cylinder see hydraulic circuit (Figure 17). The pump is supplied by the attached four quart reservoir.

The power unit controls the flow of the hydraulic fluid between the hydraulic hand pump and the wheelchair lift drive cylinder. The main components of the assembly and their functions follow.

1. End Head (Manifold) - the main body (3) of the power unit assembly, contains passages through which hydraulic fluid flows. Ports in the block are threaded to accept the valves and fittings which are required to operate the wheelchair lift drive system.

2. Pressure Relief Valve - this valve (6) protects the system from excessive pressure if one of the system valves malfunctions or if a hydraulic line or hose should be constricted.

3. Check Cap Assembly - this normally closed valve (8) maintains a set pressure in the hydraulic circuit and acts as a counterbalance to the weight of the lift.

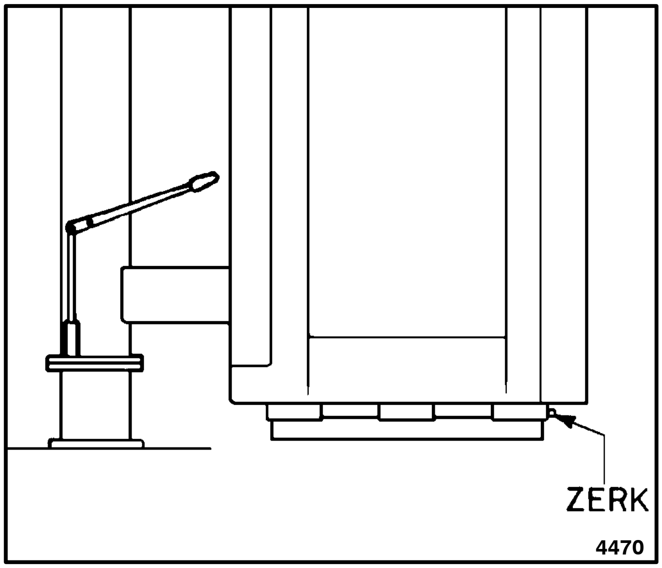

Figure 16. Lubrication Point

⚠ CAUTION ⚠

Make certain all pressure has been relieved from the hydraulic system before removing any lines, fittings or valves from the manifold.

If leakage is detected at the seals in any of the ports in the manifold, the seals must be replaced promptly. Seal kits are available for each of the valves in the manifold.

When it is determined that any of the power unit valves are not working properly, the valve will have to be serviced or replaced. Refer to the MCI Parts Manual for the proper seal kits, cartridges, coils and complete valves.

When the power unit assembly is disassembled, the block may be cleaned by flushing it out with clean solvent and then blowing out the passages with compressed air to remove any residual solvent.

TESTING MANIFOLD VALVES

To test the pressure relief valve with the coach turned off, tee in a 0-3000 psi gauge into pump outlet port. Using the hydraulic hand pump, pressurize the system. The relief valve should crack at 2250 psi.

HYDRAULIC HAND PUMP MAINTENANCE

The hand pump is located in the control box, and is piped into the lift system's hydraulic circuit (Figure 17 and 18) for use in emergency situations. The lever operated hydraulic hand pump compresses the hydraulic fluid used in the wheelchair lift system.

MANUAL RELEASE VALVE

The valve is located on the bottom of the hydraulic hand pump, and controls the lift's emergency function.

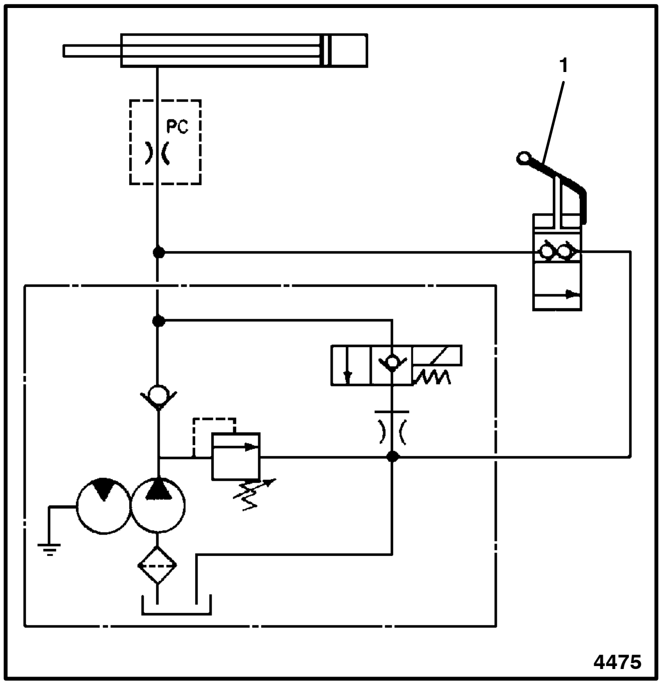

Figure 17. Hydraulic System

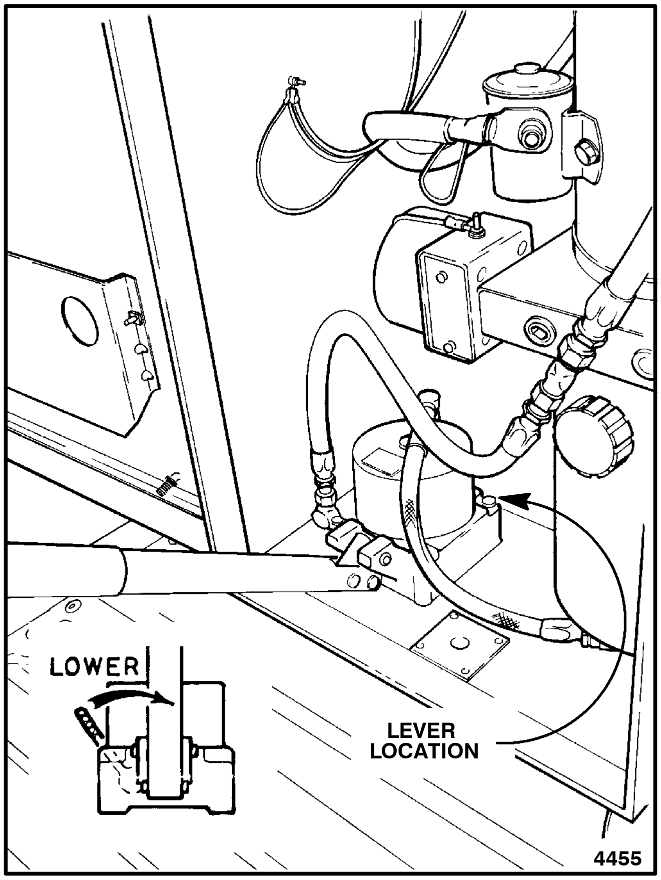

Figure 18. Hydraulic Hand Pump

Maintenance for the pump consists mainly of replacing o-ring seals if the pump begins to leak hydraulic fluid either internally or externally. External leaks are evidenced by oozing or dripping fluid at the intake and outlet ports, and at the point where the piston rod enters the pump body. Internal leaking will be detected when the pump does not pressurize the system enough to operate the drive cylinder or when the pressure drops rapidly during operation. A "spongy" feel when operating the pump lever is another sign of internal leakage. If the pump sustains damage, service parts are available. Refer to the MCI Parts Manual for the part numbers of the pump components.

WHEELCHAIR MODULE INSTALLATION

The module is bolted to a welded steel bracket at the top, and to the coach floor frame at the bottom (Figure 19). The lift structure serves as the support for the platform, ramp, drive cylinder, and guide system.

1. Lift the wheelchair lift module by the lifting point with a (1/2-13) eye-bolt.
2. Maneuver the wheelchair lift into the module cavity of the coach.
3. Attach the wheelchair lift mounting brackets to the roof cap mounting angles. Torque all mounting hardware to 65 ft-lbs.

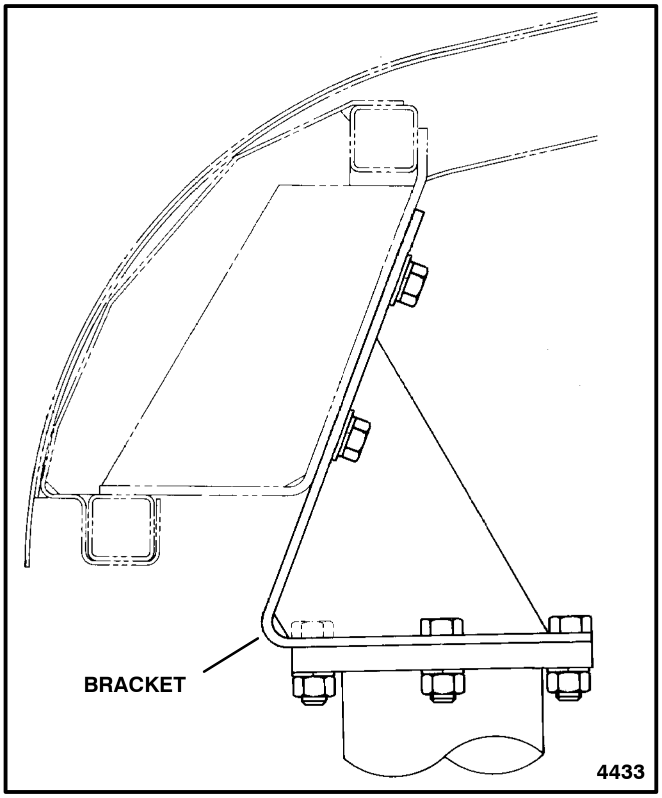

Figure 19. Lift Module Mounting Bracket

4. Move the wheelchair lift module to bring the four (4) mounting slots in line with the threaded holes in the floor mounting angle. Install, but do not torque the bolts.

5. Align the top mounting holes with the bracket and insert the bolts.

6. Torque all mounting hardware.

7. Make all of the electrical and hydraulic connections to the outboard side of the lift module.

COVER PANEL MAINTENANCE

The lift closing panel protects the passengers from contact with the lift mechanism.

1. Inspect panel for signs of excessive wear or physical damage. Replace panel as required.

2. Inspect plastic panel for signs of excessive wear or cracking. Replace as necessary.

3. Confirm the presence of all hardware and replace as required.

TROUBLESHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
No power at hand controller	Lift master switch is not in ON position.	Turn lift master on.
	Key switch for hand controller is not in ON position.	Remove key from lift master and turn key switch “ON”.
	Wiring problem.	Check for 24V on stud #10 in front J-box and stud #1 in WCL control J-box.
Door will not open	Door not unlocked.	Unlock door with ignition key.
	Door lock will not release.	Air delay valve is damaged or out of adjustment.
Platform will not lower	Up/Down switch not to DOWN position.	Turn switch to DOWN position.
	Solenoid valve malfunction.	Check for 24V across both solenoids on hydraulic block.
	Ramp not deployed.	Catch not released; release catch.
Gate will not raise	Gate mechanism requires lubrication or adjustment.	Service gate mechanism.
Platform will not raise	Up/Down switch not to UP position.	Turn Up/Down switch to UP position.
	Solenoid valve malfunction.	Check for 24V across up solenoid on hydraulic block.
Doors will not close	Ramp is not stowed.	Stow ramp.
Parking brakes will not release	Lift master switch is on.	Turn off lift master switch.
	Lift door is not closed or door closed switch is not activated.	Close doors or adjust door close switch.

SEATING AND RESTRAINT SYSTEMS

GENERAL DESCRIPTION

To provide main wheelchair parking space on the left hand side of the coach, and additional space adjacent to the lift, special single and dual pedestal sliding and folding seats have been installed (Figure 11. These seats can be folded and moved forward as far as their respective floor and sidewall tracks will allow.

OPERATION

SEAT CONVERSION

Because two different styles of seating are used, there will be separate converting instructions. The following procedures are used when converting seats.

Dual-Pedestal Seat (Right Hand Area)

1. Release the seat back (1) to the upright position.
2. Raise the seat bottoms to a vertical position (Figure 11).
3. Pull locking pin (2) in the pedestal to release the pedestal lock.
4. Pull the pedestal lock (3) up to release the sliding seat pedestal.
5. At the slider assembly in the seat's wall track, push the lever (4) down to release the sliding assembly.
6. Push the seat forward to its storage position.
7. Push down on the foot lever (3) and pull up on the wall lever (4) to lock the seat in position.

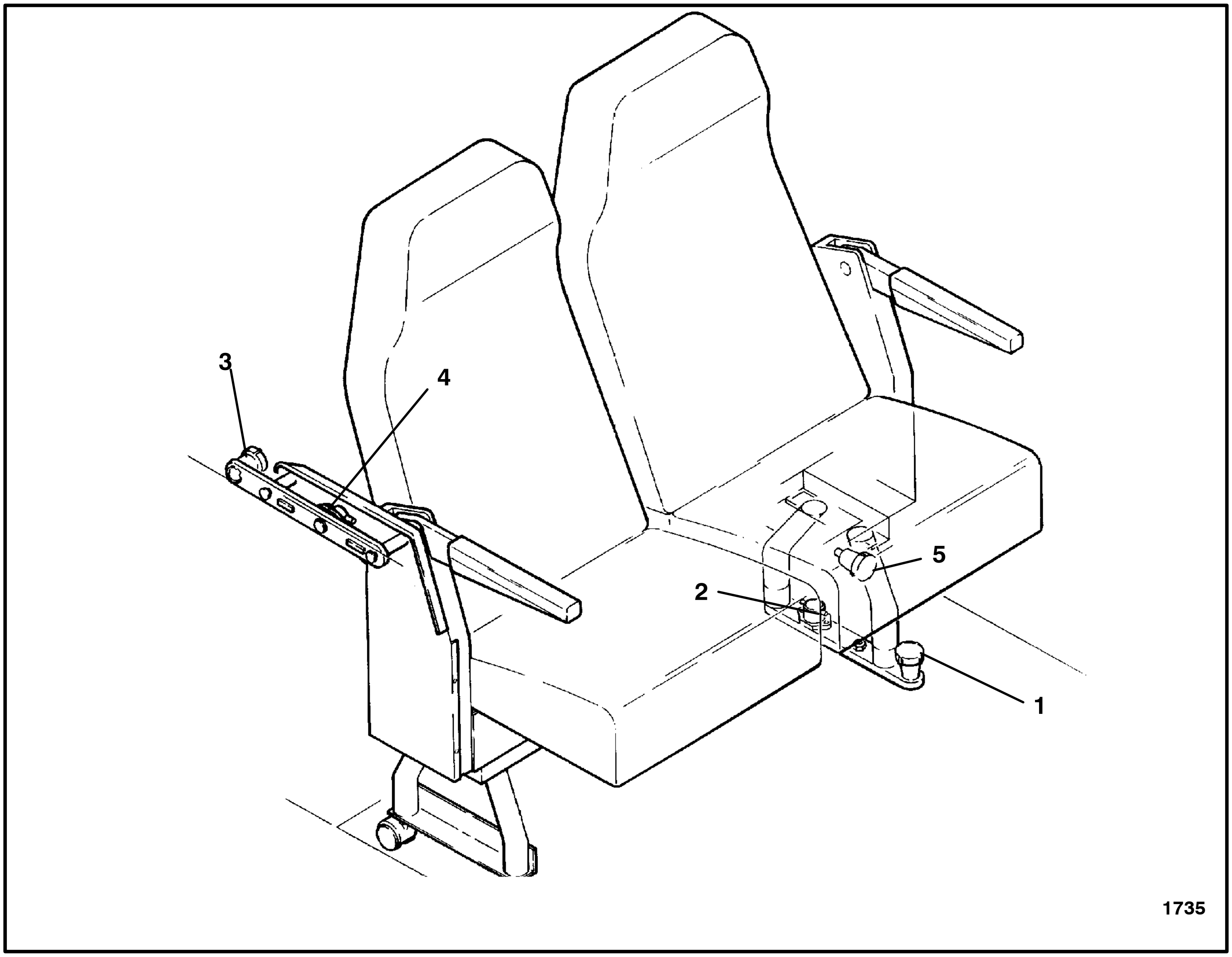

Figure 20. Sliding/Folding Seat (Right–Hand Shown)

8. Reverse this procedure to return seat to regular service.

Single-Pedestal Seats (Left Hand Area)

1. Release the seat back (1) to the upright position.

2. Raise the seat bottoms to a vertical position and secure with prop rod.

NOTE: This step releases the sidewall index plunger pin lock.

3. Pull forward and up on latch in the pedestal to release the pedestal lock.

4. Push the seat forward to its storage position.

5. Push down and rearward on the pedestal lever to lock the seat in position.

6. Reverse this procedure to return seat to regular service.

Seat Adjustments

If the seat does not lock tight enough, the clamping force can be adjusted by the jamnut (5) and resetting the clamping foot. With the pedestal locked in position, check the pedestal to floor clearance to ensure it is 0.063 inch. If the clearance is not 0.063 inch, loosen the jamnut (5) and turn the adjusting nut up or down until 0.063 inch is obtained. Retighten the jamnut.

To reset the clamping force on the wall slider assembly, loosen the jamnut (5) and turn the adjustment in or out until the proper force has been achieved.

RESTRAINTS

NOTE: Restraint belts are retracted into the floor and post cap assembly spools. Front Wheelchair belts are stowed in the parcel rack.

Wheelchair

1. Center the wheelchair between the four floor plates and move it forward to access the rear floor retractors (Figure 12).

2. Loop the rear wheelchair belting system (red) around the rear corners of the wheelchair and buckle it to the other retractor tongue (key #2).

NOTE: If belt is not long enough, it can be extended with the retractor release lever.

3. Move wheelchair to the rear and lock wheels.

NOTE: Take up any slack with the retractor release lever.

4. Attach the front retractors to each of the floor mounting plates, by lifting up on lever and inserting into floor mount and then locking lever (key #1).

5. Push down on retractor release lever and extend belts and loop around front corners of wheelchair and buckle.

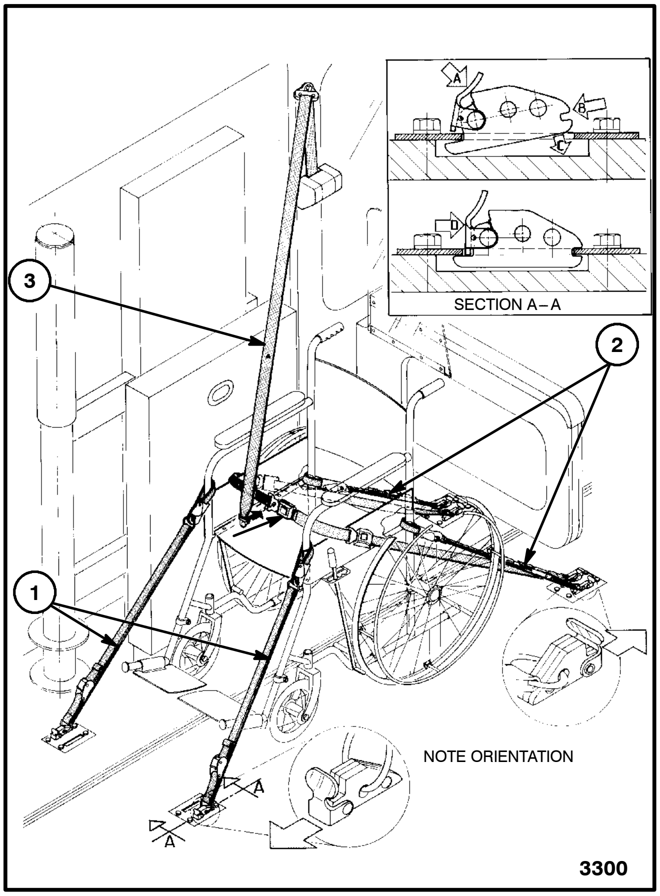

Figure 21. Wheelchair Restraint System

6. Push down on retractor release to take up any slack in the belts.

7. Pull repeatedly on the black lever of the retractor to tighten belts.

Occupant

1. Place the lap belt system (black) around the passenger and buckle to other retractor belt.

NOTE: Keep the lap belt as close as possible to the passenger's hips.

2. Attach the shoulder restraint to the lap belt assembly (key #3).

3. Remove the slack from the lap and shoulder belts by retractor releasing lever.

LIFT COMPARTMENT AND ACCESS DOOR

GENERAL DESCRIPTION

The wheelchair lift access door seals the interior of the passenger compartment from weather and unauthorized access. The door is positively locked by a latching mechanism similar to that used on the basic baggage compartment doors. The latch is operated by pulling the door handle. The door swings out to open and is keep fully open by the door prop device.

MAINTENANCE

INSPECTIONS OR CHECKS

Daily Interval

1. Check the wheelchair lift entrance light daily. Replace burned out bulbs immediately. The replacement bulbs for these lights are listed in the specifications portion of this supplement.

Six Month Interval

1. Check the door alignment and adjust if necessary.
2. Remove the ABS panel and lubricate the door catch shaft pillow blocks (2). Replace ABS panel.
3. Lubricate the door hinges with a spray type lubricant.
4. Confirm the presence of all door latching hardware.

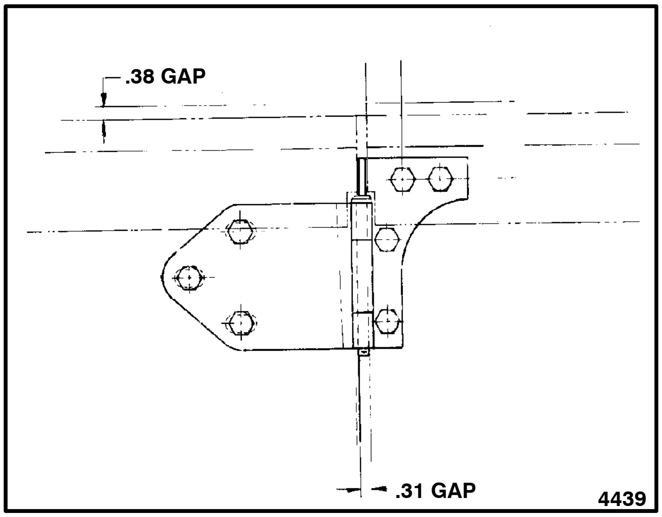

Figure 22. Lift Door Clearances (Top)

5. Inspect all moving parts of the door for signs of excessive wear. Check suspect areas more frequently and service any components that are worn or damaged.

DOOR ADJUSTMENTS

1. The wheelchair lift door should first be adjusted to fit the door opening in the coach frame and checked for proper sealing. Refer to the dimensions shown (Figures 13 and 14).
2. Mount the lift door using the dimensions shown.
3. After the lift door has been mounted, it can be adjusted up and down with the bolts on the coach body. Left and right adjustment with the bolts on the door.

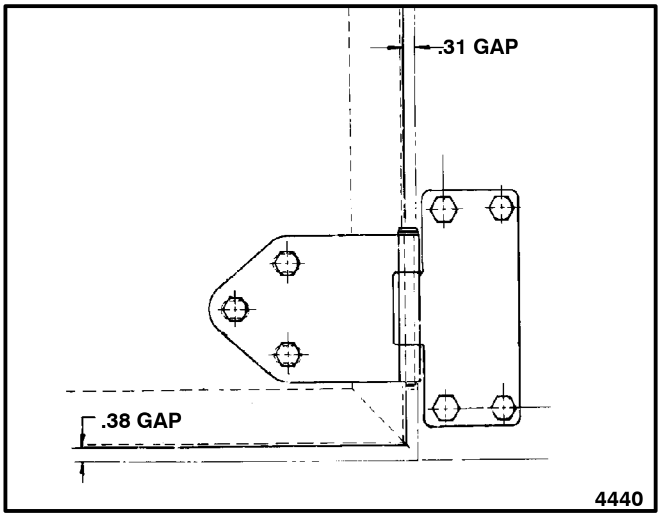

Figure 23. Lift Door Clearances (Bottom)

4. From inside the coach and check the door seals for proper sealing contact.
5. If the door locks too tightly (pinches the seal) or too loosely, adjust the door catches in or out to attain a proper seal.
6. Adjust the door control lever travel to obtain a firm over-center lock.
7. Adjust the door interlock switch so that it is fully activated in the closed position. Note that the mounting bracket for the door switch may be adjusted.

SPECIFICATIONS

LIFT ASSEMBLY

Manufacturer	STEWARD & STEVENSON CORPORATION
Model Number	SSPL550RA POWERLIFT
Voltage	24-Volt
Part Number	22K-1-210M137

WHEELCHAIR RESTRAINTS

Part Number	3L-18-522 (AMERICAN SEATING)
Part Number	3L-18-797 (NATIONAL SEATING)

LIFT COMPARTMENT & ACCESS DOORS

Part Number (Access Door)	3L-32-575-0001

ACCESS DOOR HEADER LAMP

Part Number	7K-8-560

ELECTRICAL SCHEMATICS

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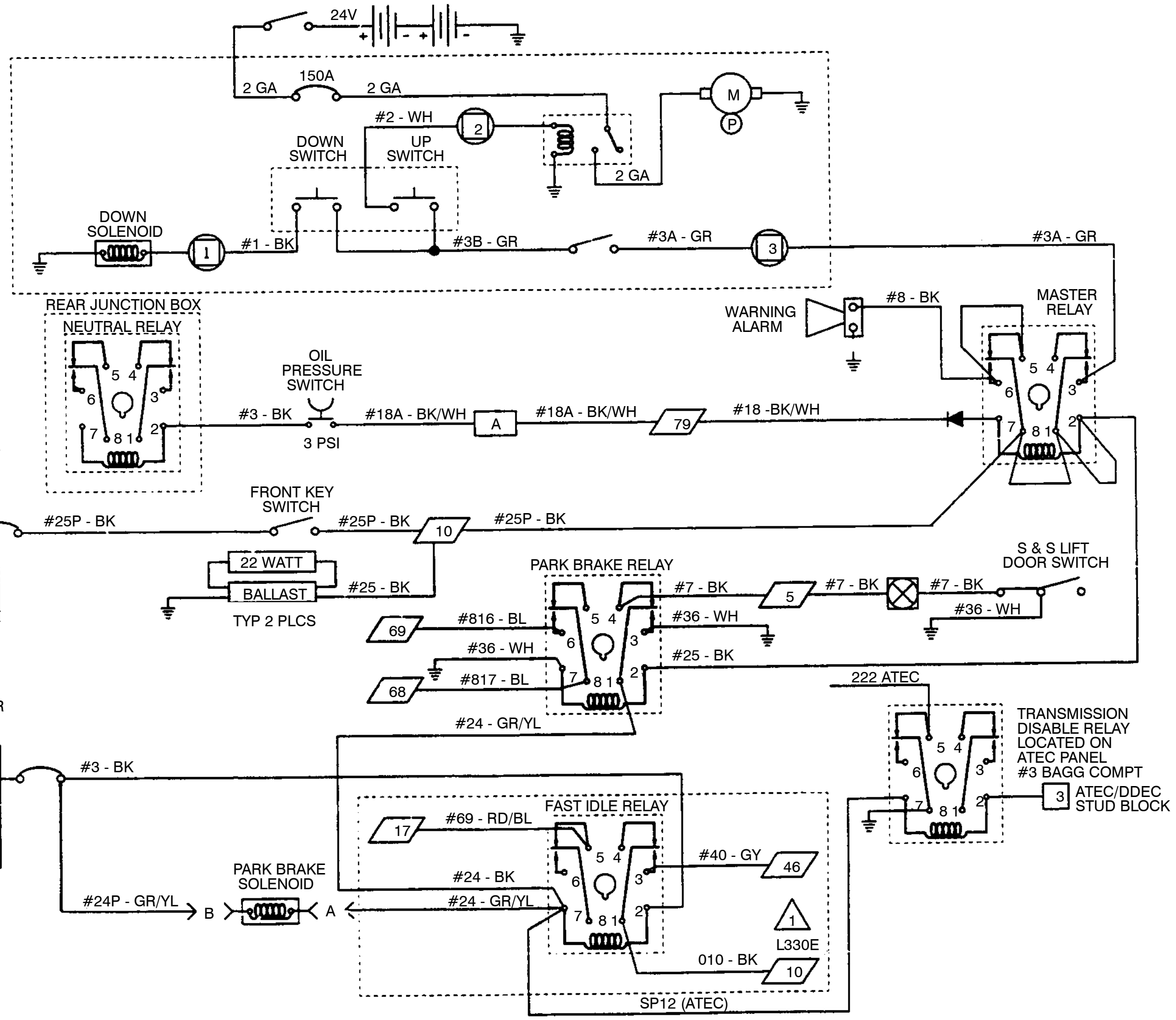
Wheelchair Lift Schematic . . . . 7L-13-1635 (Rev B)


24V
2 GA
150A
2 GA
M
P
#2 - WH
2
DOWN SWITCH
UP SWITCH
2 GA
DOWN SOLENOID
1
#1 - BK
#3B - GR
#3A - GR
3
#3A - GR
REAR JUNCTION BOX
NEUTRAL RELAY
5 4
6 3
7 8 1 2
WARNING ALARM
#8 - BK
MASTER RELAY
5 4
6 3
7 8 1 2
OIL PRESSURE SWITCH
#3 - BK
#18A - BK/WH
A
#18A - BK/WH
79
#18 -BK/WH
3 PSI
BATTERY BUSS BAR
6A
31
#25P - BK
FRONT KEY SWITCH
#25P - BK
10
#25P - BK
22 WATT
BALLAST
#25 - BK
TYP 2 PLCS
PARK BRAKE RELAY
#7 - BK
5
#7 - BK
#7 - BK
S & S LIFT DOOR SWITCH
69
#816 - BL
#36 - WH
#36 - WH
#36 - WH
#25 - BK
68
#817 - BL
5 4
6 3
7 8 1 2
222 ATEC
#24 - GR/YL
MASTER BUSS BAR
6A
#3 - BK
TRANSMISSION DISABLE RELAY LOCATED ON ATEC PANEL #3 BAGG COMPT
5 4
6 3
7 8 1 2
3
ATEC/DDEC STUD BLOCK
FAST IDLE RELAY
17
#69 - RD/BL
5 4
6 3
7 8 1 2
#40 - GY
46
#24 - BK
PARK BRAKE SOLENOID
#24P - GR/YL
B
A
#24 - GR/YL
1
L330E
010 - BK
10
SP12 (ATEC)

▱	FRT J–BOX STUD BLOCK	○	ENG CRADLE STUD BLK
▱●	FRONT J–BOX STUD	◉	ENGINE CRADLE STUD
▱○	FRT J–BOX ENT STUD BLK	⬡IL	BEHIND DASH ILLUM STUD
▭	REAR J–BOX STUD BLOCK	⬡B+	BEHIND DASH B+ STUD
▭●	REAR J–BOX STUD	⬡	BEHIND DASH GND STUD
△	A/C J–BOX STUD BLOCK	⊠	DEST SIGN STUD BLOCK
☒	PARCEL RACK STUD BLOCK	▽	SENSING ELEMENT PLUG
▢	REM CONT J–BOX HORIZ STUD BLK	⊗	ROOF HARNESS BLK STUD
◇	REM CONT J–BOX VERT STUD BLK	— —	OPTION

WH–WHITE	GR–GREEN	RD–RED
GY–GREY	YL–YELLOW	BR–BROWN
VO–VIOLET	OR–ORANGE	BK–BLACK
BL–BLUE		

LEGEND

WHEELCHAIR LIFT SCHEMATIC
102D3 & 102DL3 MODELS
EFFECTIVE WITH 1993 PRODUCTION
7L-13-1635 (REV B)

MAINTENANCE MANUAL

Date January 1998

SECTION 8

CUMMINS
L-10B (MECHANICAL)
L-10E (ELECTRONIC)
& M-11 (ELECTRONIC)
ENGINE INSTALLATIONS
& RELATED PARTS

MOTOR COACH INDUSTRIES

Printed in U.S.A.

SECTION 8

CUMMINS ENGINE INSTALLATION L-10B/E AND M-11

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ENGINE ASSEMBLY

GENERAL DESCRIPTION

The Cummins L-10B and L-10E are four-stroke cycle, right hand rotation, high speed (270/300/330 HP) high torque engines. These engines utilize a turbo-charged air intake manifold for optimum engine aspiration, with or without charge-air-cooling. The Cummins L-10B with STC is a mechanical step timing controlled engine, and the L-10E is equipped with an electronic control system for more efficient operation.

The Cummins M-11 is a four-stroke cycle, right hand rotation, high speed (330 or 370 HP) high torque engine. This engine utilizes a turbo-charged air intake manifold for optimum engine aspiration, and Cummins CELECT™ electronic control system for efficient operation.

The Cummins L-10 and M-11 engines utilize an in-line cast iron block, together with a cast iron head containing a single overhead camshaft. The camshaft actuates the two inlet and exhaust valve rocker assemblies and the one fuel injector rocker per cylinder. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshaft, power steering pump, water pump, air compressor drive and alternator accessory drive. The fuel pump is driven by the rear drive of the air compressor.

COMPONENTS

Each engine module is equipped with an oil cooler, one fuel filter assembly, a starting motor, air compressor, water pump, turbocharger and the CELECT™ electronic engine control system (M-11). Additionally, the engine is fitted with a single combination full-flow and/or by-pass oil filter assembly.

Full pressure lubrication is supplied to all main connecting rod bearings and other moving parts within the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the oil filter. From the filter a small portion is delivered to the turbocharger by an external oil line. The remainder of the filtered oil is delivered to the oil cooler or bypasses the cooler and enters the block's oil gallery. This gallery feeds oil to the cylinder head's camshaft bearings, rocker assemblies and oil control valve/manifold, while the remainder lubricates the main and connecting rod bearings.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the CELECT™ electronic engine control system's ECM, and then through the fuel filter and gear-type fuel pump. It is then forced into the fuel inlet in the cylinder heads and finally to the injectors. Excess fuel from the injectors is returned, through a restricted fitting, to the fuel tank via the outlet manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine's exhaust gas. If equipped with a Charge-Air-Cooling Installation, the air then flows through a separate air cooler adjacent to the radiator, where it is cooled and returned to the intake manifold. The cooled air is then introduced into each cylinder with the engine's intake strokes.

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual. Refer to Sections 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication). Some general specifications of these engines are shown in the following charts.

CUMMINS L-10 (330HP)

Type	**4 cycle**
Number of Cylinders	**6**
Bore (inches)	**4.921**
Bore (mm)	**125**
Stroke (inches)	**5.354**
Stroke (mm)	**136**
Comp. Ratio	**16.3:1**
Total Displacement (inches)	**611**
Total Displacement (mm)	**10.0**
Number of Main Bearings	**7**
Rated Full Load Speed (RPM)	**1800**

CUMMINS M-11 (370HP)

Type	**4 cycle**
Number of Cylinders	**6**
Bore (inches)	**4.921**
Bore (mm)	**125**
Stroke (inches)	**5.787**
Stroke (mm)	**147**
Comp. Ratio	**16.1:1**
Total Displacement (inches)	**661**
Total Displacement (mm)	**10.8**
Number of Main Bearings	**7**
Rated Full Load Speed (RPM)	**2000**

MCI Parts Books, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as "Left-Hand", "Right-Hand", "Front" or "Rear" when viewing the engine from the flywheel end. This is opposite to the position of these parts with respect to a coach installation. All parts of the coach are designated "Left-Hand", "Right-Hand", "Front" or "Rear" in relation to the normal position of the driver facing forward. Engine manufacturer's designations have been retained to eliminate potential problems in engine parts locating and identification.

OPERATION

COLD WEATHER STARTING

ETHER CUP

The coach is equipped with a cold weather starting fluid cup located on the top of the engine air intake (Figure 1). the temperature is below 40°F (4.4°C), it may be necessary to use starting fluid capsules. Use one capsule at temperatures above 0°F (−15°C), or two at lower temperatures. **Do not use more than two fluid capsules**. To use capsules, lift cover of starting fluid cup, insert capsule(s), force down over pointed tube in cup and squeeze until all fluid enters cup. Remove capsule(s) and start engine.

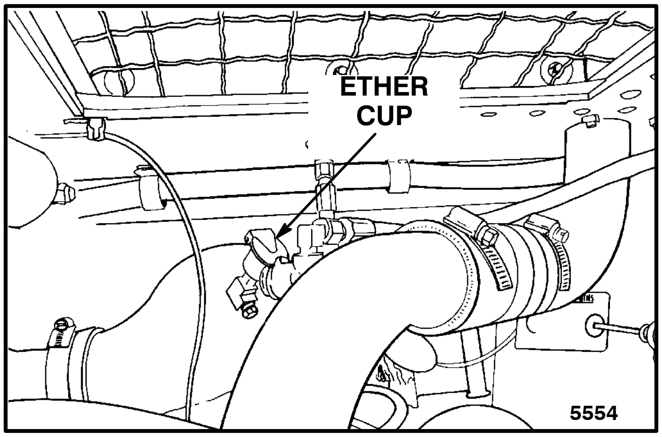


Figure 1. Ether Starting Fluid Cup

⚠ WARNING ⚠

FIRE HAZARD: Starting fluid used in the capsule is highly flammable, poisonous, and is anesthetic. DO NOT smoke while using or handling capsules, and keep away from flame or high temperatures. Avoid inhaling fumes produced by starting fluid.

K.B.I. ETHER START SYSTEM

An optional ether start system with a replaceable pressurized ether bottle can be provided. Ether is injected into the engine turbo housing when the coach is in the start mode (main switch “ON”) and the ether start switch on the driver’s left-hand switch panel is depressed. Ether travels through a line from the ether solenoid valve to an atomizer which is installed in the engine blower housing. The valve and ether bottle are mounted to a bracket attached to the underside of the coach floor at a point to the left of the aisle service door which is just in front of the rear cross seat.

The coach must be in the start mode (main switch “ON”) and the ether switch at the driver’s lower left-hand switch panel must be depressed before the ether injection process will occur. The ether start switch is wired to the starting circuit via the oil pressure switch and becomes inoperative after the engine is running and oil pressure reaches 3 psi, preventing ether injection during normal engine operation. Additionally, the ether system thermostat, which is surface mounted at the water pump housing, must sense a maximum temperature of 40°F before the solenoid valve will open and allow ether to flow to the engine.

ENGINE HEATERS

BLOCK AND OIL PAN HEATERS

An engine block heater is available. It is a 115-volt, 1500-watt, single loop element type, fitted in the block behind the crankcase dipstick.

An oil pan immersion heater is also available. It is a 115-volt, 200-watt single loop element type fitted in the side of the oil pan.

Both heaters are supplied with a 3⁄16-inch HPN cord and plug set when ordered separately. When ordered together, or with the optional lavatory tank immersion heater, a junction box is supplied. This box is installed in an exterior access door at the rear of the coach. These heaters are non-serviceable, except for the cords, and if faulty, must be replaced.

MAINTENANCE

ENGINE MODULE REMOVAL

The power module (Figure 2) including transmission, clutch, air compressor and alternator, may be removed from the coach as a unit for repair to engine or related components. Follow the removal procedure in order.

NOTE: To facilitate removal and replacement of the engine module, and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly or engine stand is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of engine dolly P/N’s 20-368 (Figure 5).

1. After coach is positioned on a twin-rail hoist of acceptable capacity, place blocks between axle bumpers and bumper stops to stabilize axle during bellows deflation.
2. Turn main battery switch to “OFF”.
3. Disconnect height control valve links and pull down to vent air from rear suspension bellows.
4. Disconnect the drive shaft as outlined in Section 14 of this manual.
5. Drain the engine cooling system as directed in Section 6 of this manual.
6. Remove the cooling fan drive belts on charge-air-cooling installations, or the blower belt on dual radiator installations.
7. Remove the air conditioning compressor drive belts.
8. Open drain cock on the ping tank, and vent air from the wet tank.

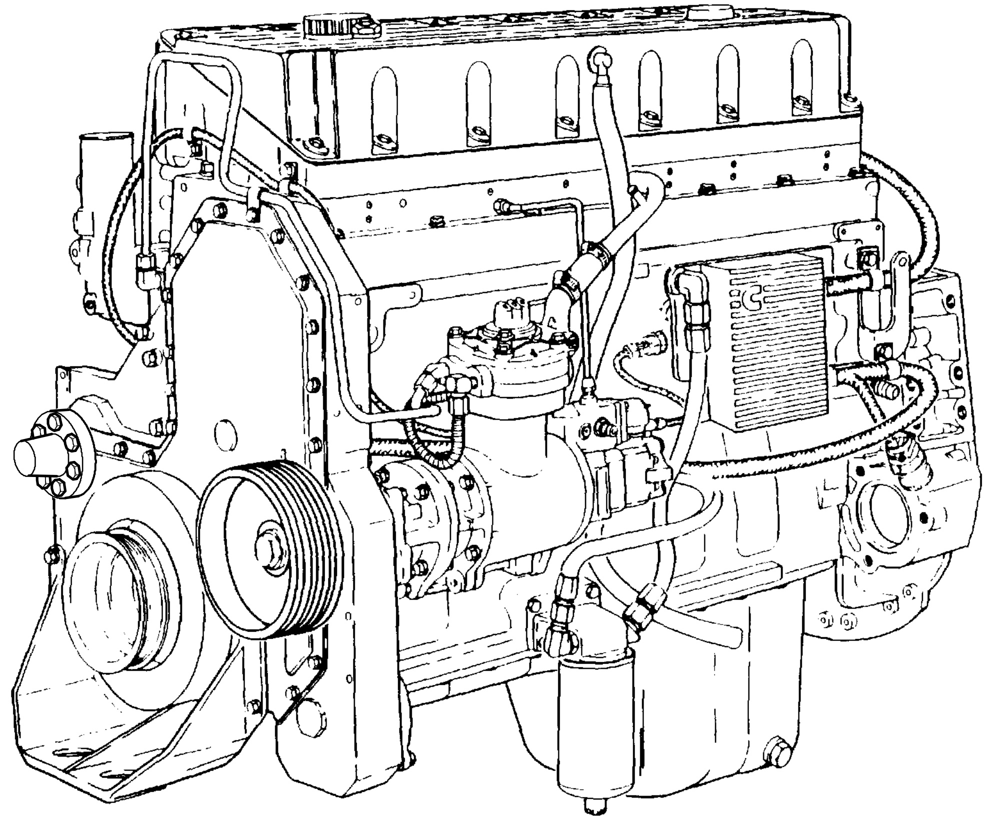


Figure 2. Power Module (CELECT Shown)

9. Disconnect discharge air line from air compressor.

10. Disconnect compressor governor air lines from air/fuel junction block.

11. Disconnect fuel supply and return lines at air/fuel junction block.

12. Disconnect exhaust and air cleaner pipe clamps from turbocharger housing.

13. Disconnect exhaust muffler slip joint and remove exhaust pipe section.

14. Disconnect and remove air cleaner pipe section from turbocharger housing's inlet, also disconnect the air compressor intake air piping.

15. Disconnect and remove the charge air inlet pipe from the turbocharger housing's outlet on CAC installations only.

16. Disconnect and remove the charge air outlet pipe from intake manifold on CAC installations only.

17. Disconnect Webasto heater exhaust pipe from engine cradle on CAC installations only.

18. Disconnect and remove Webasto heater water inlet pipe section from engine oil cooler fitting on CAC installations only.

19. Disconnect and remove the return water pipe section from engine water pump fitting on CAC installations only.

20. Disconnect and remove the return water pipe section hose connector from coach heat return line on dual radiator installations only.

21. Disconnect and remove water pump inlet pipe section from radiator assembly on CAC installations only.

22. Disconnect and remove the "Y" connector pipe for radiator return water on dual radiator installations only.

23. Disconnect and remove thermostat outlet pipe section from radiator assembly on CAC installations only.

24. Disconnect and remove thermostat "Tee" outlet pipe section from LH radiator assembly on dual radiator installations only.

25. Disconnect and remove make-up water pipe from surge tank to water pump.

26. Disconnect ground cable.

27. Disconnect starter cable.

28. Disconnect alternator wiring and mark.

29. Disconnect all input or output coach wiring harnesses of the CELECT™ system's ECM and mark, including the main CELECT™ harness at ECM.

30. Disconnect the ATEC system's main coach harness at transmission.

31. Disconnect all coach water temperature guage and switch wire harnesses on thermostat housing.

32. Disconnect Transmission shift cable (HT-740 Transmissions).

33. Disconnect transmission shift linkage (Standard Transmission).

34. Disconnect clutch cable (Standard Transmission).

35. Remove the rear bumper.

36. Raise the coach approximately 4-6 inches (101.6-152.4 mm) above floor.

37. Remove the clamp bolts securing the engine sub-frame (cradle) to the coach body.

38. Position the dolly under the engine cradle.

39. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

⚠ **CAUTION** ⚠

Due to the minimum clearance between the engine's accessories and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be 1/8 to 1/4 inch (3.1-6.3 mm).

40. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach.

ENGINE MODULE INSTALLATION

1. To reinstall, reverse the above procedure.
2. Refill cooling system.
3. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil.
4. Remove vent plugs and pour fuel oil into filter body until filters are full.
5. Start engine and check operation.
6. Check fuel and cooling system connections for leakage.
7. Test operation of engine controls and accessories.

DIESEL ENGINE LUBRICATING OILS

Coaches equipped with the Cummins L-10 and M-11 engines have an oil capacity of 38 U.S. quarts (39.9 liters) (includes filters). Oil is added through the oil fill tube (Figure 3).

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. **The only lubricating oil recommended for Cummins L-10 and M-11 diesel engines is the API Service Code CE or CF-4 -- SAE 15W-40.**

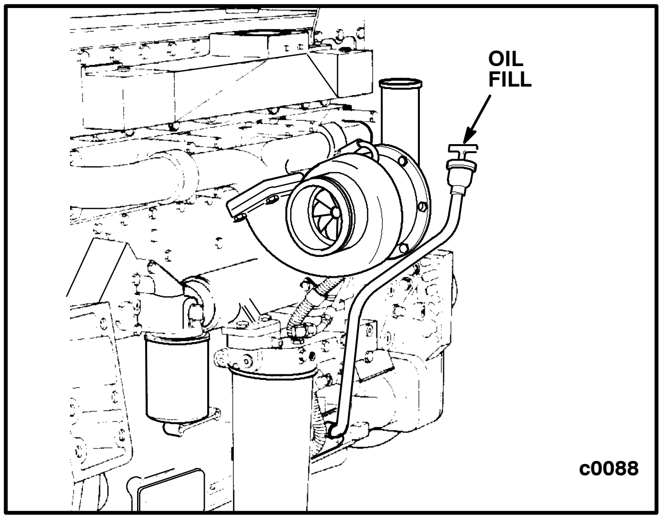


Figure 3. Oil Fill Tube

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

SYNTHETIC OILS

Synthetic oils may be used in Cummins engines, provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils. Synthetic oils offer improved low temperature flow properties and high temperature oxidation resistance.

Product information about synthetic oils should be reviewed carefully. Performance additives often respond differently in synthetic oils. The use of synthetic oil does not permit extension of recommended oil drain intervals.

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term “oil supplier” is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation

API Service Code Classification	Military Specification	SAE Grade
CF-4		15W-40
CE	MIL-L-2104D	15W-40

SAE 15W-40 grade oil is recommended in the Cummins L-10 and M-11 diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil.

NOTE: Monograde oils should not be used in these engines regardless of API Service Classification.

The Cummins L-10 and M-11 engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limit (ASTMD-874) shall not exceed 1.0% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 15W-40 with auxiliary heating. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction reducing compounds.

NOTE: MCI warranty applicable to Cummins L-10 and M-11 diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly, malfunctions attributable to neglect or failure to follow the manufacturer’s fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, the service intervals noted in the Cummins Operation and Maintenance Manual are minimum requirements to keep the engine warrant valid. Engine conditions may vary depending on the service environments from one coach to another, therefore, maintenance schedules should be formulated with the specific coach’s service conditions in mind.

A suggested preventive maintenance practice includes a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Your oil supplier knows the physical properties of his products and maintains laboratories that can determine practical oil drain intervals. Request a check of oil samples and a report of there results for each engine’s service conditions if different.

ENGINE MOUNTS

The engine is mounted to the engine cradle with four sets of beveled Metalastik mounts, two rear mounts attached to strut on each side of the flywheel housing (Figure 4) and two front mounts attached to the plate brackets on each side of the crankshaft (Figure 5). The mounts should be inspected every 24 months or 60,000 to 96,000 miles, whichever comes first, and replaced if necessary using the following procedure.

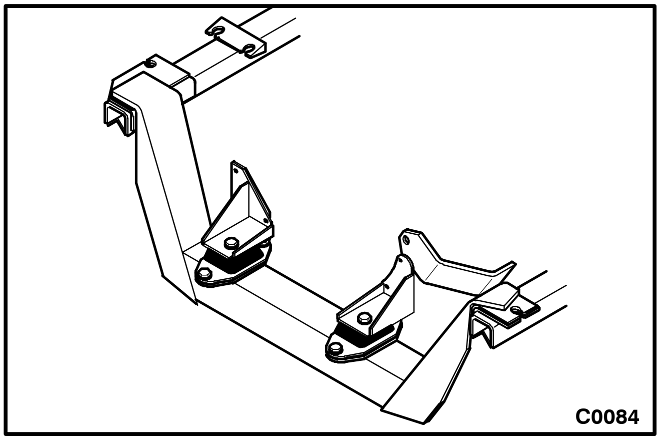


Figure 4. Rear Mount

1. Unfasten and remove the damaged mount's center bolting, and loosen all other mount fasteners to allow its removal.

2. Position jack under engine and lift until bracket is clear and mount can be removed.

3. Position new mount under bracket, and slide center bolt through mount.

NOTE: When replacing mount loosely tighten flange bolts to keep mount from moving on cradle while engine is being lowered.

4. Gently lower engine down onto engine craddle to set mount correctly onto their brackets, and hand tighten with full weight of engine bearing on cradle assembly.

⚠ CAUTION ⚠

Improper installation of the motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short periodof time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

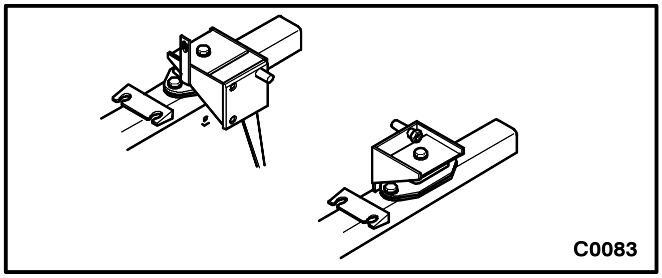


Figure 5. Front Mount

ELECTRONIC ENGINE CONTROL SYSTEMS

GENERAL DESCRIPTION

Generally speaking most diesel engine electronic control systems operate approximately in the same manner. The systems receive, process and store information from sensors located throughout the engine and other related components. Input from these and other devices determines the command signals issued to maintain the engine's proper environmental and economic operation.

The systems are responsible for the storage and retrieval of vital engine information, the processing of received data and the transmittal of command signals that will achieve correct engine functions relating to operation. The systems can be interconnected to other electrically or electronically controlled components such as transmissions and throttle devices. The following is a list of functions or tasks that a typical engine control system should address. Control of the engine's fuel injection function (i.e., timing of and fuel metering), including transient fuel control (smoke control). Communication with the transmission control system. Monitoring of rated speed and power, torque shaping, engine governing, cold start logics, engine oil, intake air and coolant temperatures.

The systems also have protection circuits that reduce power and eventually shut down the engine completely in the event of a potentially damaging engine condition, such as low oil pressure, low coolant level or high engine temperature. The systems should incorporate a self-diagnostic feature, and may identify a fault condition or potential problem by illuminating a telltale light and/or an audible alarms. Fault codes identifying failed components are logged into the system's ECM memory for later readout by maintenance personnel.

The specific system that is covered by this sub-section is the Cummins CELECT™ electronic engine control systems.

NOTE: For convenience this write-up may reference other engine manufacturer's terminology where applicable to describe the components.

COMPONENTS

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Module (ECM) is the micro-processor-controlled electronic monitoring and storage unit for an engine control system. The ECM unit mounts on the engine (Figure 6).

The ECM can identify problem conditions within the engine by comparing input from the various sensors to a set of parameters (calibration and design data) stored within the ECM. After processing the input the ECM sends high current command pulses to the injector solenoids to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder.

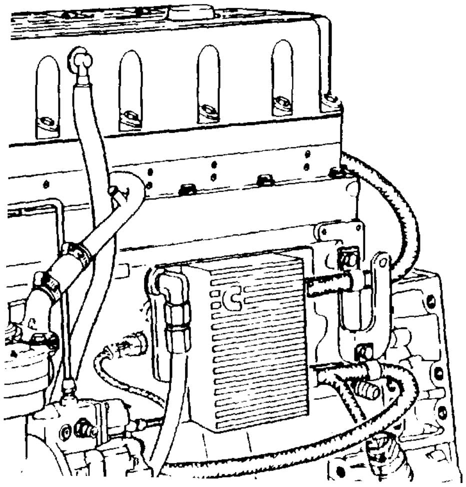

C1459

Figure 6. Electronic Control Module

Heat generated by the ECM is dissipated via an internal heat exchange process. Fuel from the fuel tank flows through the body and absorbs heat from the unit before passing through the fuel filters and into the engine.

NOTE: There are no user-serviceable parts within the ECM. If it is determined that the ECM is defective, it must be replaced in its entirety.

The ECM is factory programmed and is determined by a specific engine/transmission/tire size and axle ratio combination. Refer to the table later in this section for the factory ECM programming for particular combinations. Reprogramming will be required for any change within a combination.

VEHICLE SPEED SENSOR (VSS)

The Vehicle Speed Sensor (VSS) is located at the transmission output shaft and provides input to the ECM regarding vehicle speed. Alternate speed sensing input may be obtained through a road speed generator on earlier model coaches.

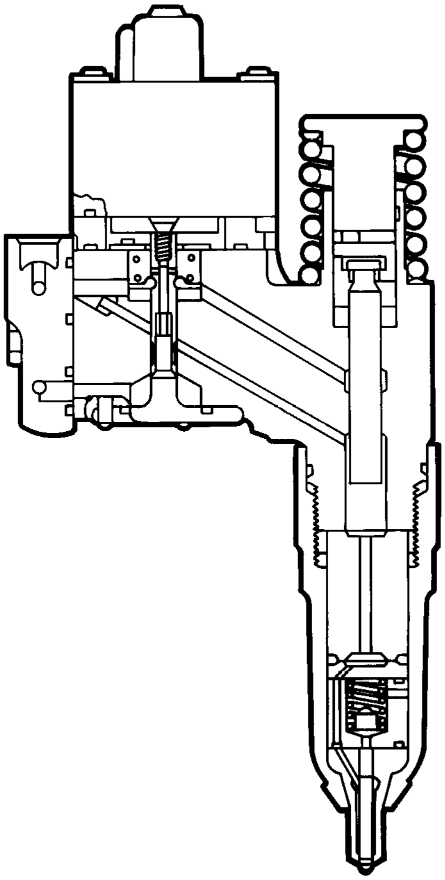

1213

Figure 7. Electronic Unit Injector

VEHICLE INTERFACE MODULE (VIM)

Some transmission's links to the engine control system's ECM requires a Vehicle Interface Module (VIM). This interface enables engines and transmissions of different manufacture to communicate vehicle speed from a VSS and other related information. Refer to Serial Communication Interface (SCI) standards SAE J-1708 and J-1587. The VIM is typically located on the engine or in the A/C & ATEC/WTEC junction box.

ELECTRONIC UNIT INJECTORS (EUI)

The Electronic Unit Injectors (EUI) (Figure 7) are electronically controlled solenoid operated fuel injectors mounted into the cylinder head above each cylinder. The solenoid-operated poppet valve on each EUI performs injection timing and fuel metering functions

Pressurization of fuel inside the injector occurs by a conventional cam-operated plunger. When the solenoid valve on the EUI is closed, fuel is pressurization and injection is initiated at beginning of injection (BOI) (Figure 8).

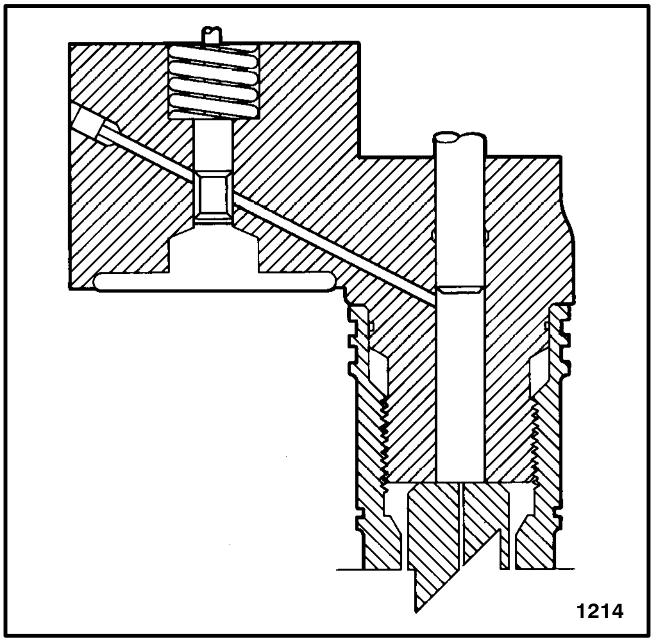


Figure 8. Solenoid Valve (Closed)

When the solenoid valve on the EUI is open pressure decreases and fuel injection ends (Figure 9). The duration of solenoid valve closure (pulse width) determines quantity of fuel injected.

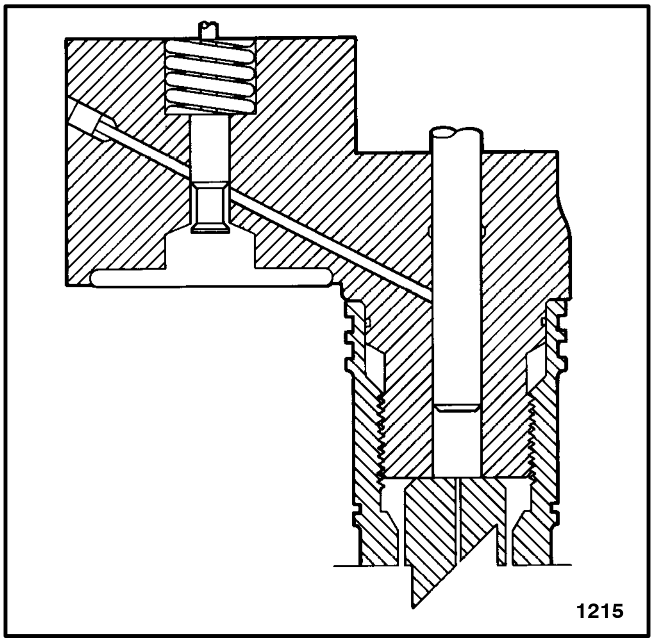


Figure 9. Solenoid Valve (Open)

ENGINE POSITION SENSOR (EPS)

The Engine Position Sensor (EPS) (Figure 10) is located on the back side of the front gear case, just above the accessory drive. The teeth on the drive gear causes the sensor to send timing pulses to the ECM. The EPS provides one signal per cylinder at its proper firing position.

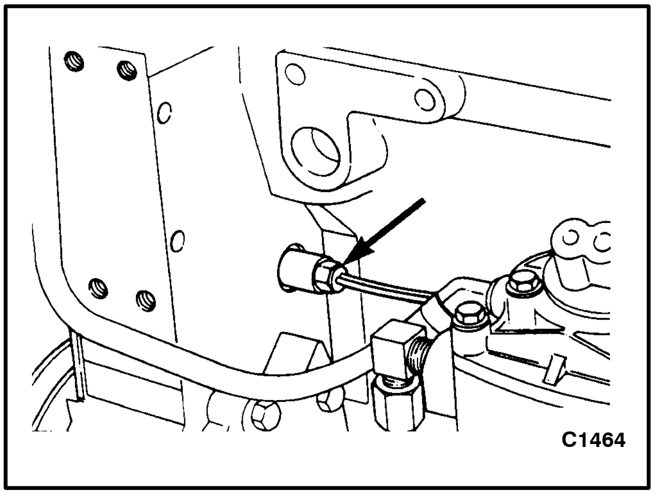


Figure 10. Engine Position Sensor

THROTTLE POSITION SENSOR (TPS)

The Throttle Position Sensor (TPS) (Figure 11) is located in the electronic foot pedal assembly (EFPA) and converts the throttle position into a signal usable by the ECM. This sensor, in effect, replaces the mechanical linkage from the accelerator treadle to the engine.

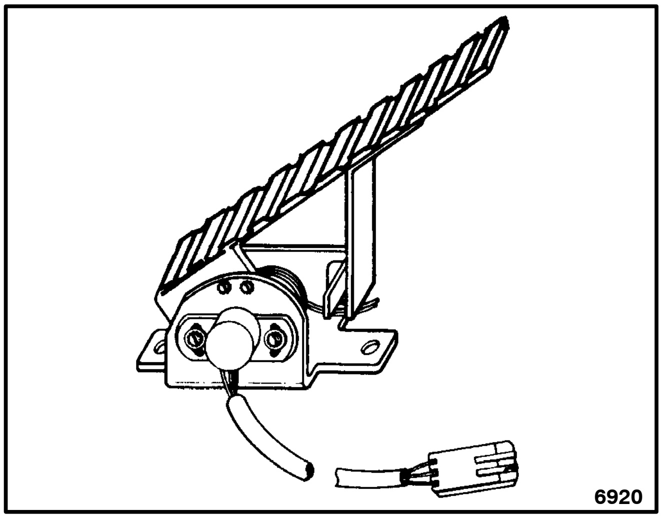


Figure 11. Throttle Position Sensor

INTAKE MANIFOLD SENSORS

The Intake Manifold Pressure & Temperature Sensors are located in the intake manifold (Figure 12). These sensors provides a signal to the ECM for the engine protection system.

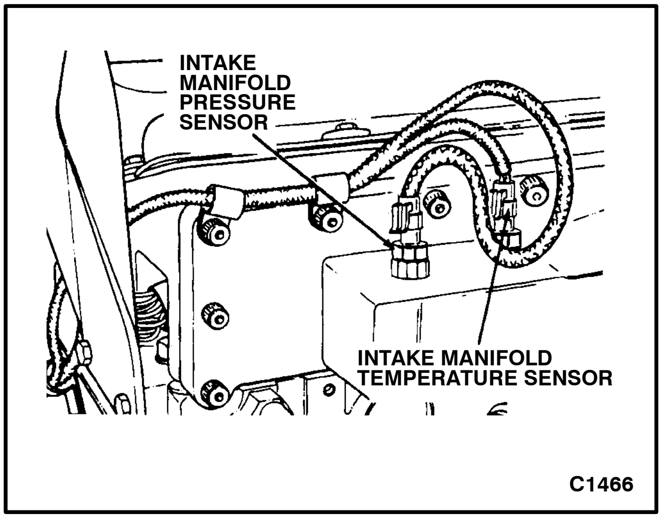

INTAKE MANIFOLD PRESSURE SENSOR
INTAKE MANIFOLD TEMPERATURE SENSOR
C1466

Figure 12. Intake Manifold Sensors

LUBE OIL SENSORS

The Oil Pressure & Temperature Sensors are located on the fuel pump side of the block (Figure 13). The oil temperature sensor is located behind the ECM. The oil pressure sensor monitors and alerts the ECM if engine oil pressure falls below a specified minimum value.

The ECM should illuminating the amber "CHECK ENGINE" light and/or the red "STOP ENGINE" telltale warning lights. The ECM may also sound an audible alarm and initiate the engine protection shut-down sequence.

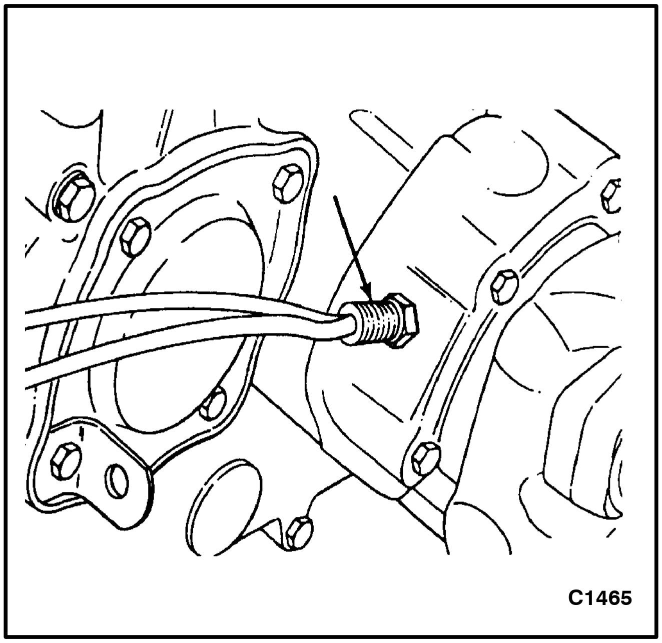


Figure 13. Oil Pressure Sensor

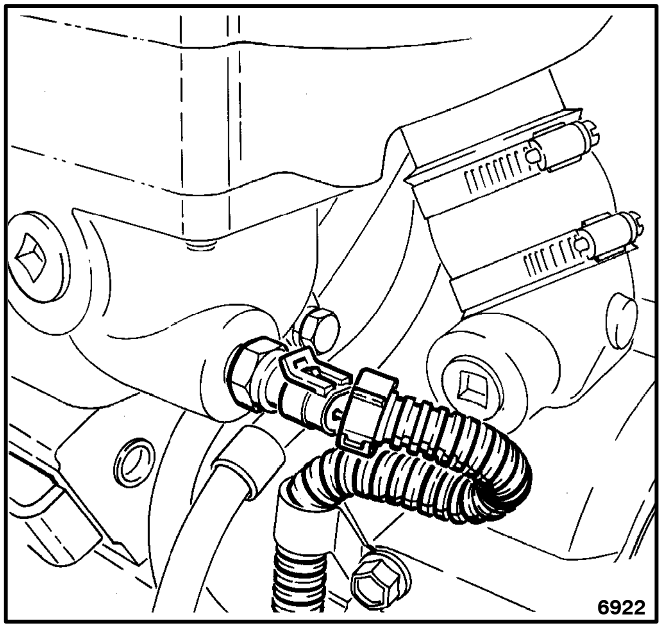


Figure 14. Coolant Temperature Sensor

COOLANT TEMPERATURE SENSOR (CTS)

The Coolant Temperature Sensor (CTS) monitors engine coolant temperature, and is mounted in the front of the engine thermostat housing (Figure 14). Additionally, the CTS input may be used in the cold start logic feature of some electronic control systems ECM.

If the coolant temperature exceeds the specified maximum the ECM will illuminate the amber "CHECK ENGINE" telltale warning light. If the coolant temperature exceeds the ECM shut-down parameters the red "STOP ENGINE" telltale warning light will illuminate. The ECM will initiate the engine protection sequence, and begin engine shut-down procedures.

NOTE: For more information on the engine protection sequence see "Diagnostic" later in this sub-section.

COOLANT LEVEL SENSOR (CLS)

The Coolant Level Sensor (CLS) assembly sends a constant signal to the ECM to indicate coolant level in the engine's cooling system. The vehicle manufacturer supplied CLS probe is located near the bottom of the radiator's surge tank, and monitors the coolant level (Figure 15).

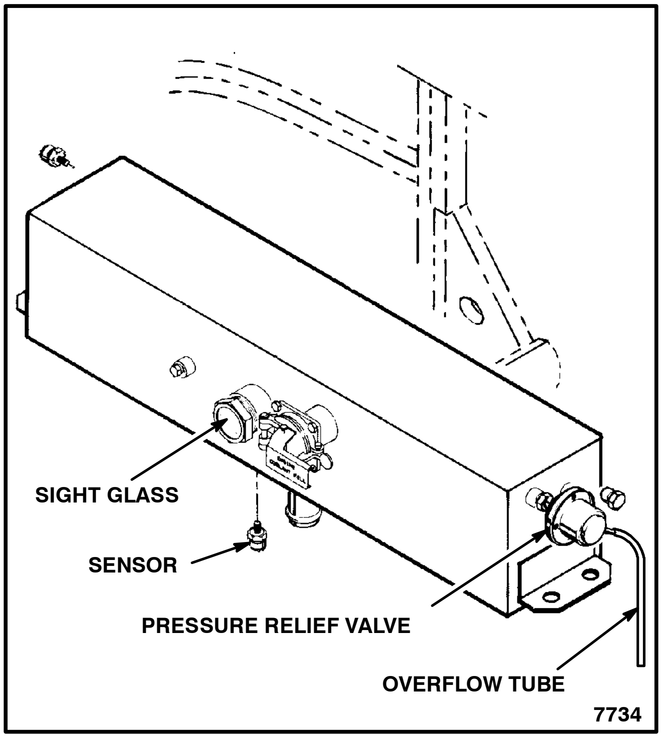


Figure 15. Coolant Level Sensor

AMBIENT AIR SENSOR

The Ambient Air Pressure Sensor (ATS) monitors the air around the engine attain input for hot or cold weather fuel metering (Figure 16).

MAINTENANCE

DIAGNOSTICS

The CELECT electronic engine control system's diagnostics feature can be separated into three areas: Engine Performance Diagnostics, Self Diagnostics and Engine System Protection.

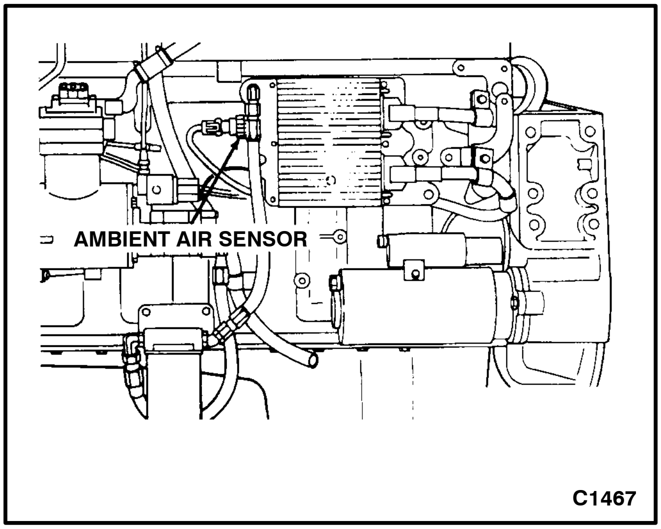


Figure 16. Ambient Air Sensor

Engine Performance Diagnostics

The CELECT system continuously monitors various sensors and makes adjustments to injector timing and fuel quantity (metering) input, depending on EEPROM programming and sensor input, to provide optimum performance and minimal acceleration smoke under all operating conditions. Cold weather starting is improved by matching the fuel input and timing to the ambient air temperature.

System Self-Diagnostics

The system continuously monitors itself and all related wiring for faults. If a fault is detected, the "CHECK ENGINE" and/or "STOP ENGINE" light(s) will illuminate (depending on the severity of the fault), and if the fault is in the main microprocessor, a backup microprocessor takes control.

When the system is under the control of the backup microprocessor the engine will continue to function normally. However, fuel injector control logic is based on the following sensor input information:

1. Throttle Position Sensor (TPS).
2. Vehicle Speed Sensor (VSS).
3. Coolant Temperature Sensor (CTS).
4. Intake Manifold Sensors.

All other sensor input is ignored and a generic set of calibration data is substituted which may degrade engine performance while in the backup mode. Auxiliary features which remain operational during backup mode are the engine protection feature.

Engine Protection (With Shutdown Sequence)

When the engine protection feature is initiated the amber "CHECK ENGINE" and red "STOP ENGINE" telltale warning lights on the left hand tell-tale cluster are illuminated (Figure 17) fault code is logged into the ECM's memory and the following power reduction sequence is begun.

A. Five seconds after fault detection power is reduced to 84% of current throttle.

B. Ten seconds after fault detection power is reduced to 68% of current throttle.

C. Fifteen seconds after fault detection power is reduced to 53%of current throttle.

D. Seventeen seconds after fault detection power is reduced to 40% of current throttle. No further reduction of power occurs past 40% throttle.

NOTE: This should give the driver enough power to move the coach to a point of safety where it can be shut down.

E. After thirty seconds all fuel is cut off completely.

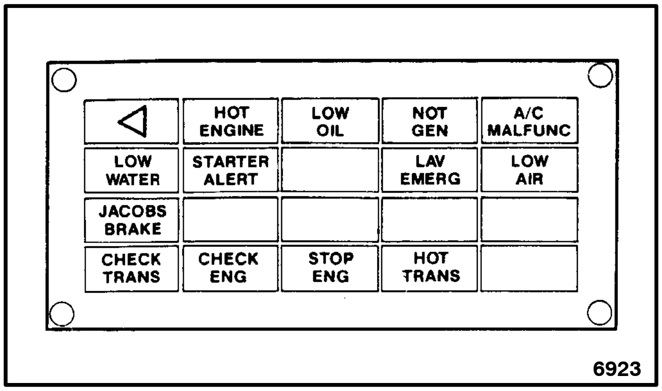

HOT ENGINE
LOW OIL
NOT GEN
A/C MALFUNC
LOW WATER
STARTER ALERT
LAV EMERG
LOW AIR
JACOBS BRAKE
CHECK TRANS
CHECK ENG
STOP ENG
HOT TRANS
6923

Figure 17. Telltale Panel

The engine overrule switch is provided on the driver's upper left-hand switch panel (Figure 18). The switch will allow an additional thirty seconds of fuel before shutdown occurs. The overrule switch is designed so that it CANNOT be held "ON" to continuously overrule shutdown.

If the engine protection feature is triggered, it will remain active until the fault goes away or the system is reset. The CELECT systems can be reset by safely parking the coach, shutting off the ignition, waiting ten seconds and then restarting the engine.

If the fault was temporary, the indicator lights on the telltale panel will go out and normal operation will resume. A fault code will be logged in memory until the memory is cleared. The memory may be cleared by use of a DDR (Figure 19). The fault may also be cleared by restarting the engine a number of times without the fault being relogged.

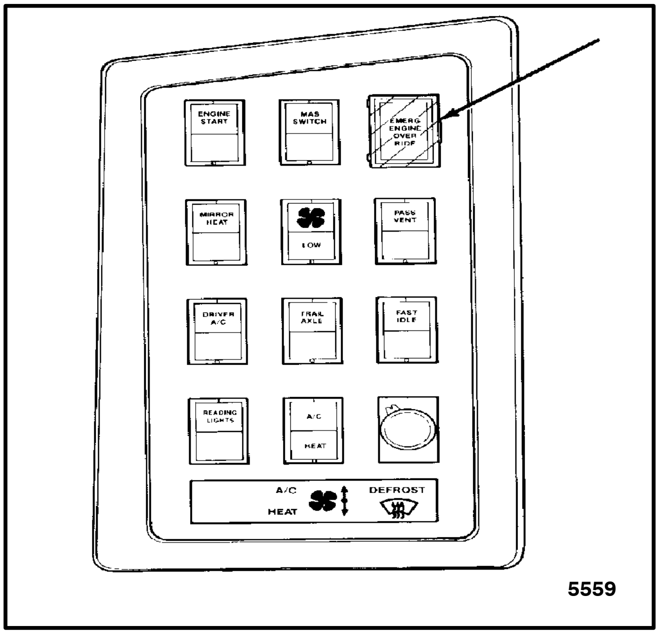

ENGINE START
MAS SWITCH
EMERG ENGINE OVER RIDE
MIRROR HEAT
LOW
PASS VENT
DRIVER A/C
TRAIL AXLE
FAST IDLE
READING LIGHTS
A/C
HEAT
A/C
HEAT
DEFROST
5559

Figure 18. Stop Engine Override Switch

If the fault remains after the engine is restarted, the problem is not temporary, and maintenance or repair of the problem is indicated.

TROUBLESHOOTING

The replacement of any internal engine components should be based on diagnostic codes indicating faulty components. Refer to the applicable system's troubleshooting manual and/or the appropriate instruction manual for the diagnostic data reader being used for complete information on diagnosis of components.

Troubleshooting the CELECT systems can be divided into the following two areas. The first being mechanical checks such as wiring and connector problems. The second being the proper use of the DDR, and the interpreting of the logged codes.

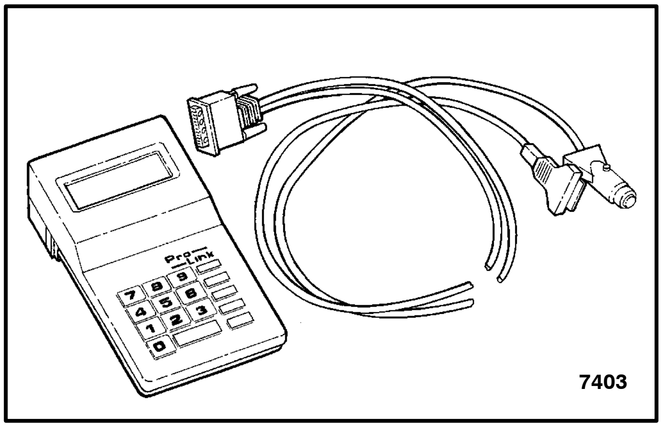
Mechanical Checks

Mechanical checks involve checking all wiring and connectors for proper connection, dirty or corroded terminals and visual inspection of components for loose, damaged, or missing parts.

All wiring is Teflon coated with crimp-type connectors. Solder-type connectors are not used nor recommended on wiring because normal vibration will cause the solder connection to fail in time.

Diagnostic Data Reader

The Diagnostic Data Reader (DDR) is a hand-held electronic device that can be connected to either of the two DDL's for accessing and review of logged fault codes (Figure 19).


Pro-Link
7
8
9
4
5
6
1
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3
0
7403

Figure 19. Diagnostic Data Reader

The Diagnostic Data Link (DDL) connectors are installed on the coach and enable the user to connect a DDR to access and interpret the fault codes logged into the ECM's memory and /or operational data.

One of the two DDL connectors are located in the A/C & ATEC/WTEC junction box. The other connector is located under the dashboard near the steering column.

The DDR should be able to electronically troubleshoot all system components and related wiring. Operation of the DDR should be in accordance with the "Diagnostic Data Reader User's Manual". Refer to the instruction book provided for complete diagnostic procedures.

If a DDR is not immediately available, the fault codes logged in the ECM's memory can be interpreted by use of the diagnostic switch on the LH switch panel. Turn the switch on and note the flashing light on the telltale panel. The light should flash a sequence of codes which identify the faulty component or system. For example, if the light flashes once, then pauses and flashes three more times, this would indicate a fault code 13, which is interpreted as a problem with the coolant level sensor.

Refer to the Cummins CELECT Troubleshooting Guide for a complete listing of the fault codes and their meanings.

NOTE: Read the "WELDING CAUTION" in this books introduction before beginning any welding procedures on coaches equipped with an electronic engine control system.

JACOBS ENGINE BRAKE SYSTEM

GENERAL DESCRIPTION

The Jake Brake™ engine brake feature effectively converts a power producing diesel engine into a power absorbing air compressor.

Generally, all Jake Brake™ engine brake installations operate in much the same manner. The basic difference between engine brake function is the number of brake modules (one per cylinder) utilized in the installations. The engine brake feature may be selected for either a half-force, two thirds or a full-force application depending on the amount of power to be absorbed.

The engine brake mechanically opens the cylinder exhaust valves near the top of the normal compression stroke, and releases the compressed cylinder charge to create an exhaust blowdown. Blowdown of the compressed air to atmospheric pressure prevents return energy for engine operation on an expansion stroke, the effect being a net energy loss since work done in compressing the cylinder charge is not utilized.

COMPONENTS

There are very few components in a typical engine brake installation. Some of the main components are the housing assembly, the selector switch, wire harness and any related switches associated with other equipment.

HOUSING ASSEMBLY

The main component of the engine brake is the housing assembly, (one per cylinder). The housing is mounted atop the cylinder head above each set of exhaust valves and the injector.

The housing assembly includes the master and slave pistons, the control valve with ball check, oil accumulator, the solenoid valve, and internal oil passages.

SELECTOR SWITCH

The selector for the engine brake feature is a three position type switch, located on the left hand switch panel.

OPERATION

The following is a simplified version of the operational sequence for a typical engine brake cycle (Figure 20)

A. Energizing the engine brake solenoid valve permits engine lube oil to flow under pressure through the control valve into the master and slave piston circuit.

B. Oil pressure causes the master piston and its extension to move down, coming to rest on the injector rocker clevis.

C. The injector rocker clevis begins upward travel (as in normal injection cycle) forcing the master piston upward and creating a high pressure oil flow to the slave piston. The ball check valve in the control valve imprisons high pressure oil in the master slave piston system.

D. The slave piston under the influence of the high pressure oil flow moves down momentarily opening the exhaust valve while the engine piston is near its top dead center position releasing compressed cylinder air to the exhaust manifold.

E. Compressed air escapes to atmosphere completing a compression braking cycle.

To retard a coach on a downgrade using the Jake Brake™, the operator selects a gear which will provide a balance between engine speed and road speed. If the engine speed exceeds maximum rated rpm, for a desired road speed, a higher gear can be selected, or intermittent use can be made of the vehicle service brakes.

The selection of successively lower gears will generally allow complete control of the vehicle by the Jake Brake™ leaving the vehicle service brakes in reserve to be used for emergency stops. After some practice most drivers will know what combination of gears will give the best results over a particular route.

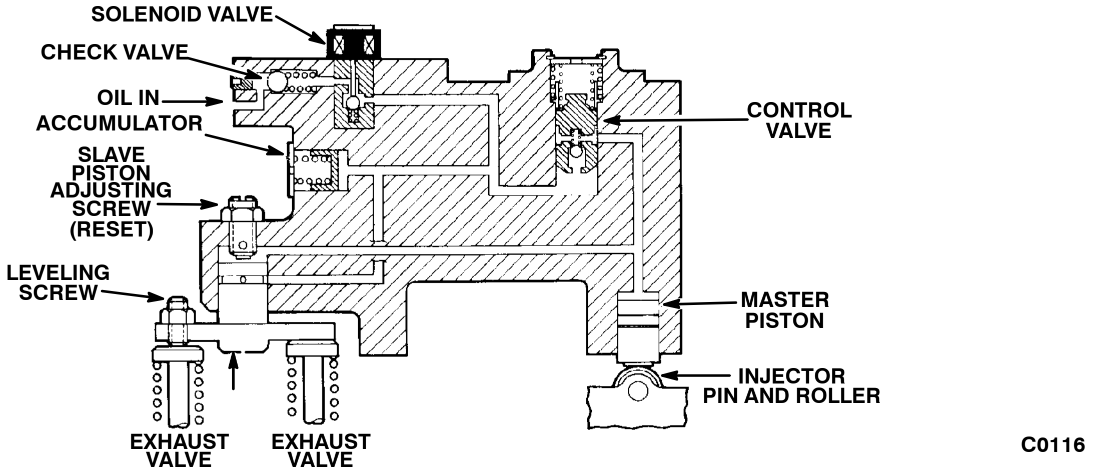
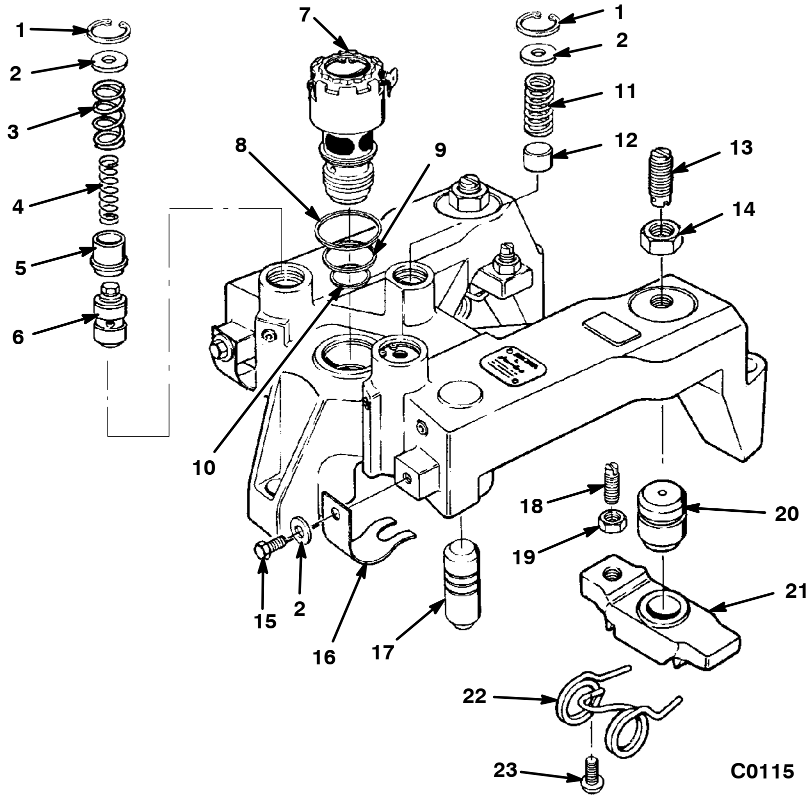

SOLENOID VALVE
CHECK VALVE
OIL IN
ACCUMULATOR
SLAVE PISTON ADJUSTING SCREW (RESET)
LEVELING SCREW
EXHAUST VALVE
EXHAUST VALVE
CONTROL VALVE
MASTER PISTON
INJECTOR PIN AND ROLLER
C0116

Figure 20. Engine Brake Operational Schematic (Cummins)

1	RETAINING RING
2	WASHER
3	STOP SPRING
4	SPRING
5	COLLAR
6	CONTROL VALVE
7	SOLENOID VALVE
8	SEAL RING, UPPER
9	SEAL RING, CENTER
10	SEAL RING, LOWER
11	SPRING
12	PISTON, ACCUMULATOR
13	RESET SCREW ASSY, HEX NUT
14	SCREW
15	FLAT SPRING
16	FLAT SPRING
17	MASTER PISTON
18	ADJUSTING SCREW
19	HEX NUT
20	SLAVE PISTON
21	BRIDGE
22	TORSION SPRING
23	BUTTONHEAD SCREW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C0115

Figure 21. Engine Brake Housing Assembly (Cummins)

MAINTENANCE

The Jacobs engine brake installations are relatively trouble-free. However, inspections to and adjustments of the installations along with parts replacement will need to be made periodically. Use the following procedures to access the installations when needed.

Note: Cummins installations can have engine brake modules on every cylinder.

SOLENOID VALVE REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 21).

Note: Most engine brake installations will allow the solenoid valves to be removed from the housing while housing is still attached to the cylinder head.

1. Remove the valve cover from the engine.
2. Disconnect the wiring from the solenoid valve.
3. Using 7/8 inch socket and extension, unscrew solenoid valve (Figure 22).

⚠ CAUTION ⚠

Do not disassemble or tamper with the solenoid valve. The solenoid valve contains no serviceable parts.

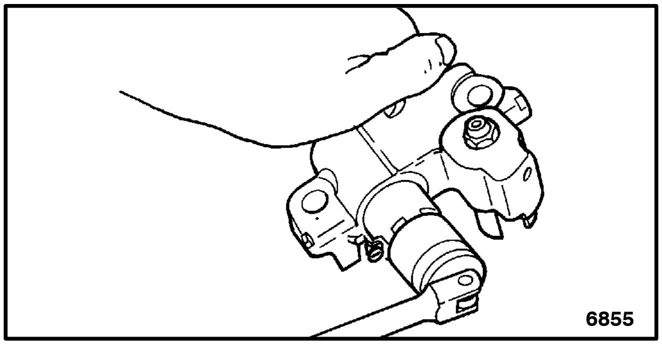


Figure 22. Remove Solenoid Valve

4. Remove and discard the three rubber O-ring seals (Figure 23). If the lower ring stays in the bottom of housing solenoid bore, remove with a piece of wire.

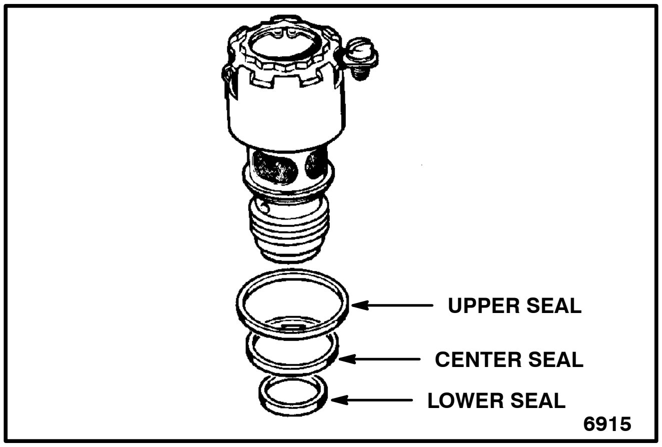


Figure 23. Remove Solenoid Valve Seals

5. Clean the solenoid valve with approved cleaning solvent. Use a brush to clean the oil screen. Dry the valve with compressed air.
6. Clean the solenoid valve bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.
7. Coat the new solenoid O-ring seal with clean lube oil before installing.
8. Install the upper and center O-ring seals on the solenoid body, and the lower seal ring into the bottom of the solenoid bore in the housing (Figure 24).

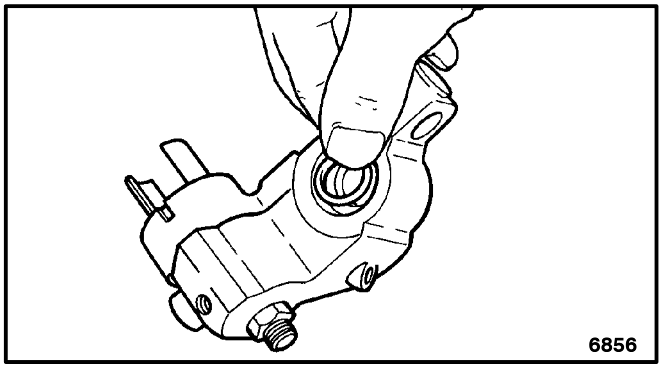


Figure 24. Install Solenoid Valve Seals

9. Be sure the seals are seated properly and carefully screw the solenoid into housing without unseating the seals. Torque the valve to 60 in-lbs (7 N·m). Be careful not to twist the seals while installing.

CONTROL VALVE REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 21).

⚠ WARNING ⚠

Remove the control valve retaining rings carefully. Control valves are under load from the control valve springs. Use care in removing to avoid personal injury.

1. Remove the Jake Brake housing assembles from the cylinder head by reversing the system installation procedure for housings.
2. Press down on the control valve washer using an appropriate rod to relieve spring pressure
3. Remove retaining ring using retaining ring pliers.
4. Continue by following steps 4 through 8 of the previous procedure.

SLAVE PISTON REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 21).

1. Remove the capscrew and torsion spring that retains the slave piston and bridge assembly.
2. Remove the bridge and piston from its bore.
3. Loosen the leveling screw locknut and remove the leveling screw from the bridge.

4. Continue by following steps 5 and 6 of the previous procedure.

5. Reinstall, via reverse procedure with the leveling screw toward the center of the housing.

6. Position the torsion spring with the ends over bridge grooves.

7. Install the spring capscrew and torque to 15 ft-lbs (20 N·m).

⚠ CAUTION ⚠

While tightening the screw on the torsion spring, push the sprig towards the slave piston assembly. Failure to do so may result in contact between the intake valve adjusting screw and torsion spring, resulting in serious engine damage.

MASTER PISTON REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 21).

1. Remove master piston retaining spring capscrew from housing and slide piston out of its bore.

2. Remove, clean and inspect all components.

3. Clean the slave piston bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.

4. Lube the master piston and insert into bore. the piston should move freely without binding.

5. Reverse the procedure to assemble piston and torque to100 in-lbs (10 N·m).

SYSTEM INSTALLATION

Before beginning clean and remove the rocker covers. If the engine is equipped with an aluminum two piece valve cover, remove only the upper cover to access engine brake. Removal of the fuel supply and drain tubes may allow easier access. To remove the tubes loosen nuts on injector and risers at back of cylinder head Save all fuel tubing for reuse (Figure 25).

Note: Some procedures and/or steps herein will be specifically addressing the retrofitting of Jake Brakes™ to existing engines. These procedures and/or steps may not be applicable to normal maintenance tasks.

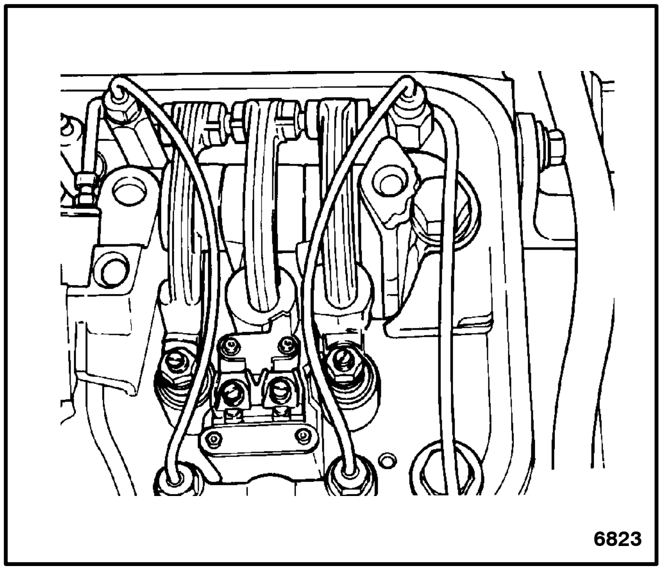


Figure 25. Removing Fuel Supply And Drain Pipes

Brake Housing

Note: Some minor differences exist between these installations, i.e. housing configurations. Follow the Jacobs Brake™ installation booklet that matches the specific engine being fitted.

If retrofitting Jake Brakes™ to existing engine, install the undercover wire harness before installing brake housings. See “Solenoid Valve Harness procedure that follows. Secure the harness to the spacer bars only after mounting housings.

1. Remove the two front bearing capscrews on the intake manifold side.

2. Insert the two housing spacer bars on the exhaust manifold side of the cylinder head with the “out” markings adjoining each other and facing the exhaust manifold.

3. Place the two engine brake housings over the rocker shafts and spacer bars with the solenoid valves toward the camshaft side of the engine.

4. Install a washer onto each of the housing capscrews and insert into the housing (3 capscrews per housing).

5. Before torquing housing capscrews, move the housing from side to side and position at midpoint of movement.

6. Torque the housing capscrews per the following sequence.

A. Tighten camshaft side capscrews to 40 ft-lbs (55 N·m) torque.

B. Tighten exhaust side capscrews to 40 ft-lbs (55 N·m) torque.

C. Repeat the above sequence and torque to 80 ft-lbs (110 N·m).

Solenoid Valve Harness

1. Remove the mounting flange cover for the EUI harness of cylinder head.

2. Insert the wires leads to the Jake Brake™ solenoid harness through the access holes in the grommet from outside in.

Note: Once the wires are inserted through the grommet, they cannot be removed due to the terminal's locking tangs.

3. Install the solenoid harness along side of the injector harness, with its end connector located outboard of the last rear harness standoff.

4. Insert the wire lead's pin housing into the undercover solenoid harness' connector.

5. Install pins to the ends of the wire leads, and insert the wire lead's pins into the housing.

Note: Do not reverse the wire lead to harness connection color codes, or improper engine brake sequencing will occur.

6. Bend all of the electrical terminals at the injectors upwards about 90 degrees to provide clearance for the engine brake housings.

Clutch Microswitch

A Jake Brake™ clutch microswitch is used with the standard transmission installations. The switch is normally closed when clutch is disengaged (pedal out) to permit Jake Brake™ operation. When clutch is engaged (pedal in) the Jake Brake™ circuit is broken and Jake Brakes™ are momentarily off (during downshift).

The microswitch is mounted to the clutch pedal mounting bracket attached to the driver's kick panel. (Figure 26). The proper positioning of the microswitch allows the switch to be activated during clutch pedal play before actual clutch disengagement occurs.

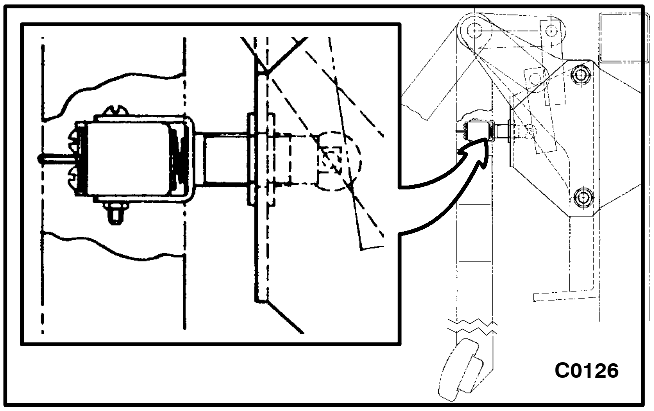


Figure 26. Clutch Microswitch Mounting

Positioning of the switch is done by means of the jamnuts which hold the switch to its bracket. Loosen and tighten these nuts to achieve the desired direction of movement of the switch towards or away from the clutch shaft lever.

When positioning the switch, avoid placing it so close to the lever arm that the switch contacts are damaged by excessive pressure.

Dash Mount Switch

The Jacobs engine brake switch is located in the lower center of the right-hand switch panel, to the right side of the driver (Figure 27).

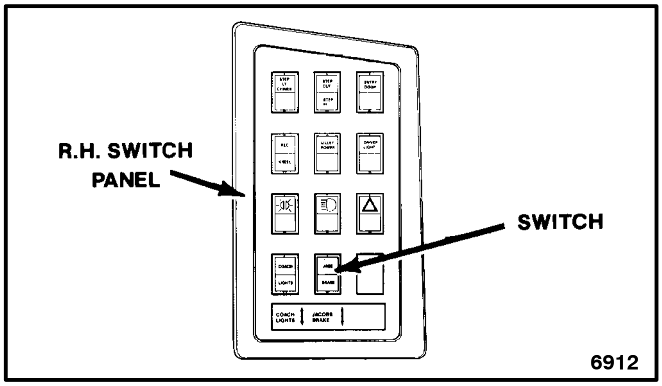


Figure 27. Jacobs Engine Brake Switch

The switch contacts are protected against arcing by a small diode connected between the load side solenoid valve switch terminals and ground. The engine brake must be connected to the load side terminal. Refer to the Jacobs Engine Brake wiring diagram in sub-section 7J.

Half or full operation of the engine brake may be selected by moving the switch on the dash to the intermediate position for operating half of the engine brakes, or by moving it to the upper position which brings both engines banks into operation.

When the switch is in the fully downward position, the engine brake is off.

Engine braking will not begin unless the driver's foot is removed from the accelerator pedal.

ADJUSTMENTS

The following are general adjustment procedures for setting the intake/exhaust valves, injectors and slave piston clearance.

For specific information on settings and tools consult the engine manufacturer's service publications and/or the engine data plate located on the engine.

Fuel Injector Height

1. Rotate the engine until any one of the injector followers has just begun its downward stroke and note the number of this cylinder.

Note: The Timing Circle Method may be used to adjust engine injectors and valves.

2. Place the injector timing gauge in the hole provided in the top of the injector body with the flat of the gauge toward the injector follower.

3. The flat of the injector gauge should just pass over the top of the injector follower. If it does not, loosen the push rod locknut and turn the push rod to obtain the proper clearance.

4. Hold the push rod and tighten the locknut to 35 ft-lbs (47 N·m). Adjust all the remaining injectors in the same manner as outlined above. Follow the firing order for the specific engine being adjusted.

Exhaust Valves

1. Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

2. Loosen the exhaust valve rocker arm push rod locknut.

3. Place a feeler gauge between the valve bridge and the valve rocker arm pallet. Adjusting the push rod to obtain a smooth pull on the feeler gauge.

Note: Checking and Setting feeler gauge dimensions can be found in the specifications at the end of this sub-section.

4. Remove the feeler gauge. Hold the push rod with a 5/16-inch wrench and tighten the locknut with a 1/2-inch wrench.

5. Check the clearance using the check dimensions for the specific engine.

OPERATIONAL CHECK

⚠ CAUTION ⚠

Always check the fuel system for leaks after injector or fuel pipe replacement and any time the fuel connections under the rocker cover are suspected of leaking. Failure to correct a serious fuel leak in the area can lead to dilution of the lube oil and bearing and/or cylinder wall damage.

After operating the engine for 20-30 minutes shut it off and remove the rocker covers. Inspect the lube oil puddles that normally form where the fuel connectors join the cylinder head and where the fuel pipes join the fuel pipe nuts.

If there is any leakage at a connection, the lube oil puddles will appear smaller or thinner than the puddles on connectors that are not leaking. Disassemble, inspect, and correct or replace the suspect part (connector washer, connector, injector or jumper line). Test and reinspect.

Never remove any engine brake component with engine running. Personal injury may result.

1. The Jake Brake™ dash switch should be in the “OFF” position, (engine brake solenoid not energized).

2. Move the shift selector to “Neutral” with the clutch pedal released (clutch engaged)

3. Start the engine and allow to warm up for a few minutes.

4. Move the dash switch to the Half-Force braking position.

5. Accelerate the engine above idle and release throttle pedal.

Note: Only one bank should operate during engine deceleration and shut off just above idle speed.

Note: On non-electronically controlled engines, if the engine brake does not shut off before reaching idle speed or shuts off too early, reset the buffer screw adjustment.

6. Move the dash switch to the Full-Force braking position.

7. Accelerate the engine above idle and release throttle pedal.

Note: All engine brakes should operate during engine deceleration and shut off before reaching idle.

8. Depress the clutch pedal to open the contacts in the clutch switch. With the dash switch in Full-Force braking position, accelerate the engine and release the pedal. The engine brakes should not operate with the clutch disengaged (pedal depressed).

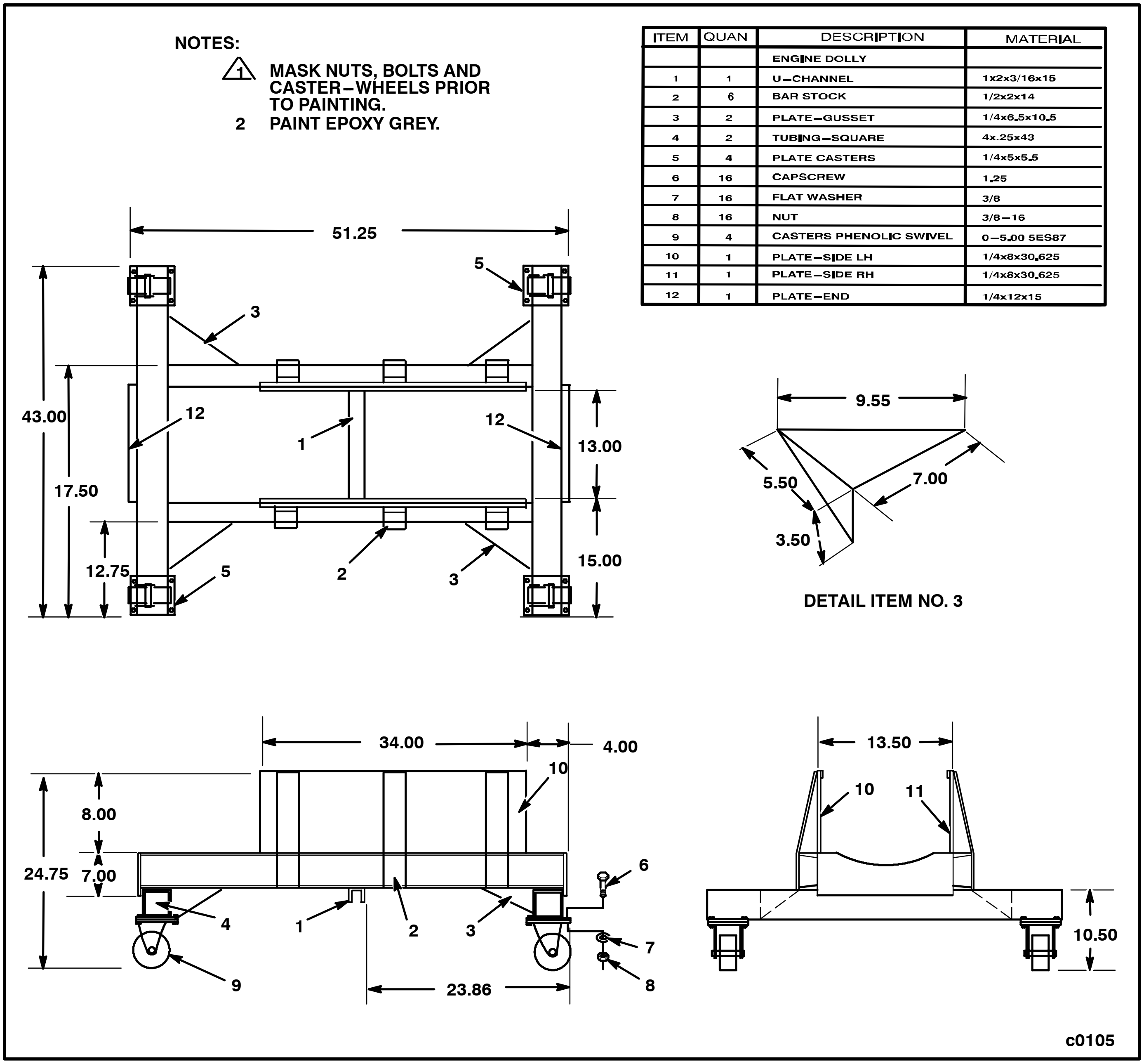
⚠ CAUTION ⚠

If any of the above conditions are not met, recheck all installation procedures for correctness.

9. Install rocker cover and gasket. Torque cover hold down bolts to 20 ft-lbs (27 N·m).

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.



NOTES:

△1 MASK NUTS, BOLTS AND CASTER–WHEELS PRIOR TO PAINTING.
2 PAINT EPOXY GREY.

ITEM	QUAN	DESCRIPTION	MATERIAL
		ENGINE DOLLY	
1	1	U–CHANNEL	1x2x3/16x15
2	6	BAR STOCK	1/2x2x14
3	2	PLATE–GUSSET	1/4x6.5x10.5
4	2	TUBING–SQUARE	4x.25x43
5	4	PLATE CASTERS	1/4x5x5.5
6	16	CAPSCREW	1.25
7	16	FLAT WASHER	3/8
8	16	NUT	3/8–16
9	4	CASTERS PHENOLIC SWIVEL	0–5.00 5ES87
10	1	PLATE–SIDE LH	1/4x8x30.625
11	1	PLATE–SIDE RH	1/4x8x30.625
12	1	PLATE–END	1/4x12x15

51.25
5
3
43.00
17.50
12.75
12
1
12
13.00
15.00
5
2
3
9.55
5.50
7.00
3.50
DETAIL ITEM NO. 3
34.00
4.00
10
8.00
24.75
7.00
6
4
1
2
3
7
9
23.86
8
13.50
10
11
10.50
c0105

Figure 28. Engine Dolly

MISCELLANEOUS ENGINE TORQUE VALUES

FOR COMPLETE ENGINE SPECIFICATIONS REFER TO THE APPROPRIATE CUMMINS ENGINE SERVICE MANUAL.

Front Motor Mount Center Bolts (Rear of Coach)	75–80 ft.lbs. (100–110 N·m)
Rear Motor Mount Center Bolts (Near Transmission)	110–125 ft.lbs. (150–170 N·m)
Rear Motor Mount Strut-to Engine Locknuts	155 ft.lbs. (210 N·m)
Crankshaft Vibration Damper Bolts	150 ft.lbs. (203 N·m)
Crankshaft Pulley Bolts	50 ft.lbs. (67 N·m)
Oil Drain Plug	65 ft.lbs. (88 N·m)
Alternator Drive Pulley Bolt	400 ft.lbs. (542 N·m)
Alternator Pulley Nut	210 ft.lbs. (284 N·m)
Alternator Mounting Bracket Bolts	70 ft.lbs. (94 N·m)
Starter Mounting Bolts	130 ft.lbs. (176 N·m)
Air Compressor Housing-to-Gear Case Bolts	35 ft.lbs. (47 N·m)
Air Compressor to Housing-Bolts	50 ft.lbs. (67 N·m)
Steering Pump Adapter -to-Gear Case Bolts	35 ft.lbs. (47 N·m)
Steering Pump to Adapter Bolts	20 ft.lbs. (27 N·m)

SPECIFICATIONS

OIL FILTER ASSEMBLY

Part Number	3318853 (Cummins)
Part Number	LF3000 (Fleetguard)
Design	Spin-On Full-Flow
Location	(Filter Head Mounted) LH Engine

FUEL FILTER ASSEMBLY

Part Number	3315843 (Cummins)
Part Number	FS1212 (Fleetguard)
Design	Spin-On
Location	(Filter Head Mounted) RH Engine

WATER CHARGE FILTER ASSEMBLY

Part Number	3318201 (Cummins)
Part Number	WF2072 (Fleetguard)
Design	Spin-On
Location	(Filter Head Mounted) LH Engine

MAINTENANCE MANUAL

Date January 1998

SECTION 8

CATERPILLAR
3176B & C-10 (ELECTRONIC)
ENGINE INSTALLATIONS
& RELATED PARTS

MOTOR COACH INDUSTRIES

Printed in U.S.A.

SECTION 8

CATERPILLAR ENGINE INSTALLATION 3176B & C-10

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ENGINE ASSEMBLY

GENERAL DESCRIPTION

The Caterpillar 3176B and C-10 are four-stroke cycle, right hand rotation, high speed high torque (325 or 350 & 370 HP) engines. These engines utilize a turbo-charged air intake manifold for optimum engine aspiration, and Caterpillar's electronic control system for efficient operation.

The Caterpillar 3176B and C-10 utilize an in-line cast iron block, together with a cast iron head containing a single overhead camshaft. The camshaft actuates the two inlet and exhaust valve rocker assemblies, and the one fuel injector rocker per cylinder. The vertically aligned gear train, located in the gear case at the front end of the engine, contains drive gears off of the crankshaft for the lubricating oil pump, camshaft, power steering pump, water pump, air compressor drive and alternator accessory drive. The fuel pump is rear gear-case driven.

COMPONENTS

Each engine module is equipped with an oil cooler, one fuel filter assembly, a starting motor, air compressor, water pump, charge water filter, turbocharger and the electronic engine control system. Additionally, the engine is fitted with a single combination full-flow/by-pass oil filter and oil cooler assembly.

Full pressure lubrication is supplied to all main, connecting rod bearings and other moving parts within the engine. A gear-type pump draws oil from the oil pan through an intake screen and delivers it to the oil filter, from the filter, a small portion is delivered to the turbocharger by an external oil line. The remainder of the filtered oil is delivered to the oil cooler, or bypasses the cooler, and enters the block's oil gallery. This gallery feeds oil to the cylinder head's camshaft bearings and rocker assemblies, and the remainder lubricates the main and connecting rod bearings.

Coolant is circulated through the engine by a centrifugal-type water pump. The cooling system, including the radiator and surge tank, is a closed-type system. Heat is removed from the coolant by the radiator. Control of the engine temperature is accomplished by thermostats which regulate the flow of the coolant within the cooling system.

Fuel is drawn from the fuel tank through the rear gear-case driven fuel pump, and then through the electronic engine control system's ECM, through the fuel filter and into the fuel supply and return manifold. It is then forced into the fuel inlet in the cylinder heads and finally to the injectors. Excess fuel from the injectors is returned to the fuel tank via the manifold and connecting lines. Since the fuel is constantly circulating through the injectors, it serves to cool the injectors and also carries off any air in the fuel system.

Fresh air is drawn through the air cleaner assembly by the turbocharger which is powered by the engine's exhaust gas. The air then flows through the Charge-Air-Cooler in the radiator assembly, where it is cooled and returned to the intake manifold. The cooled air charge is then introduced into each cylinders with the engine's intake strokes.

Some general specifications of this engine are shown in the following chart.

Engine Specifications
Caterpillar 3176B

Type	4 cycle
Number of Cylinders	6
Bore (inches)	4.922
Bore (mm)	125
Stroke (inches)	5.5
Stroke (mm)	140
Comp. Ratio	16:1
Total Displacement (inches)	628
Total Displacement (mm)	10.3
Number of Main Bearings	7
Rated Full Load Speed (RPM)	2100

Maintenance and repair information on the engine will be found in the engine manufacturer's service manuals. Engine controls, accessories and related components are covered in the applicable sections of this manual. Refer to Sections 6 (Cooling), 7 (Electrical), 9 (Fuel), and 10 (Lubrication).

MCI Parts Books, Maintenance Manuals, Service Bulletins and other technical publications identify all engine parts as "Left-Hand", "Right-Hand", "Front" or "Rear" when viewing the engine from the flywheel end. This is opposite to the position of these parts with respect to a coach installation. All parts of the coach are designated "Left-Hand", "Right-Hand", "Front" or "Rear" in relation to the normal position of the driver facing forward. Engine manufacturer's designations have been retained to eliminate potential problems in engine parts identifications and locations.

OPERATION

COLD WEATHER STARTING

ETHER CUP

The coach is equipped with a cold weather starting fluid cup located on the top of the engine air intake (Figure 1). If the temperature is below 40°F (4.4°C), it may be necessary to use starting fluid capsules. Use one capsule at temperatures above 0°F (−15°C), or two at lower temperatures. **Do not use more than two fluid capsules**.

To use capsules, lift cover of starting fluid cup, insert capsule(s), force down over pointed tube in cup and squeeze until all fluid enters cup. Remove capsule(s) and start engine.

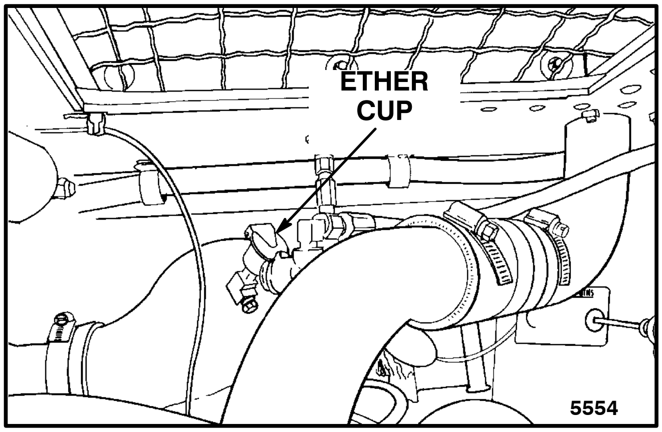


Figure 1. Ether Starting Fluid Cup

⚠ WARNING ⚠

FIRE HAZARD: Starting fluid used in the capsule is highly flammable, poisonous, and is anesthetic. DO NOT smoke while using or handling capsules, and keep away from flame or high temperatures. Avoid inhaling fumes produced by starting fluid.

K.B.I. ETHER START SYSTEM

An optional ether start system with a replaceable pressurized ether bottle can be provided. Ether is injected into the engine turbo housing when the coach is in the start mode (main switch “ON”) and the ether start switch on the driver’s left-hand switch panel is depressed. Ether travels through a line from the ether solenoid valve to an atomizer which is installed in the engine blower housing. The valve and ether bottle are mounted to a bracket attached to the underside of the coach floor at a point to the left of the aisle service door which is just in front of the rear cross seat.

The coach must be in the start mode (main switch “ON”) and the ether switch at the driver’s lower left-hand switch panel must be depressed before the ether injection process will occur. The ether start switch is wired to the starting circuit via the oil pressure switch and becomes inoperative after the engine is running and oil pressure reaches 3 psi, preventing ether injection during normal engine operation. Additionally, the ether system thermostat, which is surface mounted at the water pump housing, must sense a maximum temperature of 40°F before the solenoid valve will open and allow ether to flow to the engine.

ENGINE HEATERS

BLOCK AND OIL PAN HEATERS

An engine block heater is available. It is a 115-volt, 1500-watt, single loop element type, fitted in the block behind the crankcase dipstick.

An oil pan immersion heater is also available. It is a 115-volt, 200-watt single loop element type fitted in the side of the oil pan.

Both heaters are supplied with a 3/16-inch HPN cord and plug set when ordered separately. When ordered together, or with the optional lavatory tank immersion heater, a junction box is supplied. This box is installed in an exterior access door at the rear of the coach. These heaters are non-serviceable, except for the cords, and if faulty, must be replaced.

MAINTENANCE

ENGINE MODULE REMOVAL

The power module (Figure 2) including transmision, clutch, air compressor and alternator, may be removed from the coach as a unit for repair to engine or related components. Follow the removal procedure in order.

NOTE: To facilitate removal and replacement of the engine module, and to provide a convenient means of supporting the engine and related components during service work, the use of a dolly/engine stand is recommended. Such a dolly may be made locally. Refer to tool listings at the end of this section for drawing of engine dolly P/N’s 20-377 (Figure 27).

1. After coach is positioned on a twin-rail hoist of capacity, place blocks between axle bumpers and bumper stops to stabilize axle during bellows deflation.
2. Turn main battery switch to “OFF”.
3. Disconnect height control valve links and pull down to vent air from rear suspension bellows.
4. Disconnect the drive shaft as outlined in Section 14 of this manual.
5. Drain the engine cooling system as directed in Section 6 of this manual.
6. Remove the cooling fan drive belts.
7. Remove the air conditioning compressor drive belts.
8. Open drain cock on the ping tank, and vent air from the wet tank.
9. Disconnect discharge air line from air compressor.
10. Disconnect compressor governor air lines from air/fuel junction block.
11. Disconnect fuel supply and return lines at air/fuel junction block.
12. Disconnect exhaust and air cleaner pipe clamps from turbocharger housing.
13. Disconnect exhaust muffler slip joint and remove exhaust pipe section.
14. Disconnect and remove air cleaner pipe section from turbocharger housing’s inlet
15. Disconnect and remove the charge air inlet pipe from the turbocharger housing’s outlet.
16. Disconnect and remove the charge air outlet pipe from intake manifold.
17. Disconnect Webasto heater’s exhaust pipe from engine craddle.
18. Disconnect and remove Webasto heater’s water inlet pipe section from engine oil cooler fitting.
19. Disconnect and remove the return water pipe section from engine water pump fitting.
20. Disconnect and remove water pump inlet pipe section from radiator assembly.
21. Disconnect and remove thermostat outlet pipe section from radiator assembly.
22. Disconnect and remove make-up water pipe from surge tank to water pump.
23. Disconnect ground cable.

24. Disconnect starter cable.

25. Disconnect alternator wiring and mark.

26. Disconnect all input or output coach wiring harnesses of the electronic engine control system's ECM and mark, including the main electronic control harness at ECM.

27. Disconnect the ATEC system's main coach harness at transmission.

28. Disconnect all coach water temperature guage and switch wire harnesses on thermostat housing.

29. Disconnect Transmission shift cable (HT-740 Trans).

30. Disconnect transmission shift linkage (Standard Transmission).

31. Disconnect clutch cable (Standard Trans).

32. Remove the rear bumper.

33. Raise the coach approximately 4-6 inches (101.6-152.4 mm) above floor.

34. Remove the clamp bolts securing the engine sub-frame (cradle) to the coach body.

35. Position the dolly under the engine cradle.

36. Lower the coach body only sufficiently to transfer the weight of the engine onto the dolly.

⚠ **CAUTION** ⚠

Due to the minimum clearance between the engine accessories and the top of the engine compartment, extreme care should be used to lower the coach body only enough to free the engine cradle. Clearance between engine cradle and coach engine mounting rail should be 1/8 to 1/4 inch (3.1-6.3 mm).

37. Remove engine assembly as a unit, carefully withdrawing it from the rear of the coach.

ENGINE MODULE INSTALLATION

1. To reinstall, reverse the above procedure.

2. Refill cooling system.

3. If engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil.

4. Remove vent plugs and pour fuel oil into filter body until filters are full.

5. Start engine and check operation.

6. Check fuel and cooling system connections for leakage.

7. Test operation of engine controls and accessories.

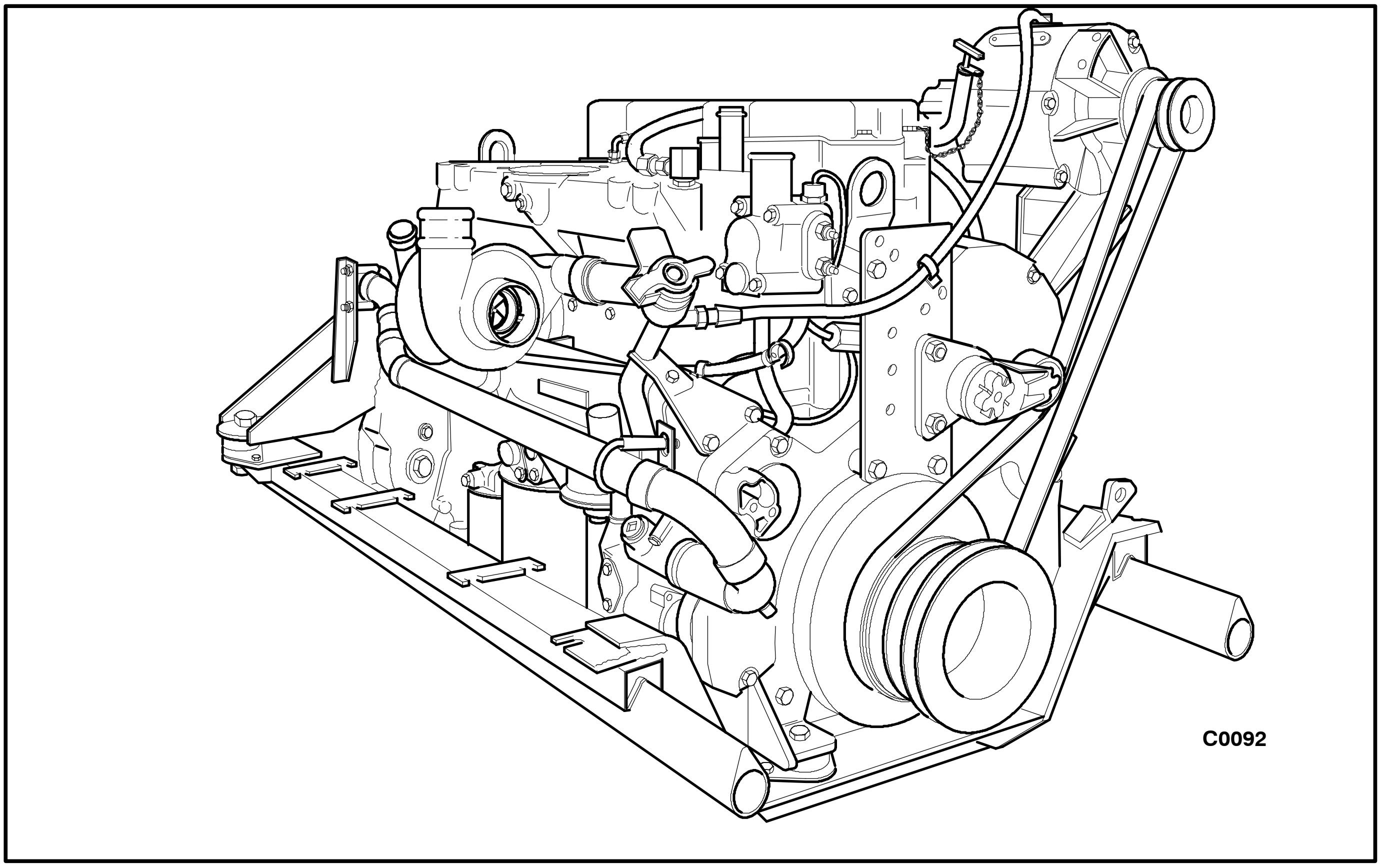


Figure 2. Power Module

DIESEL ENGINE LUBRICATING OILS

Coaches equipped with a Caterpillar 3176B or C-10 engine have an oil capacity of 30 U.S. quarts (28 liters). Oil is added through the oil fill tube (Figure 3).

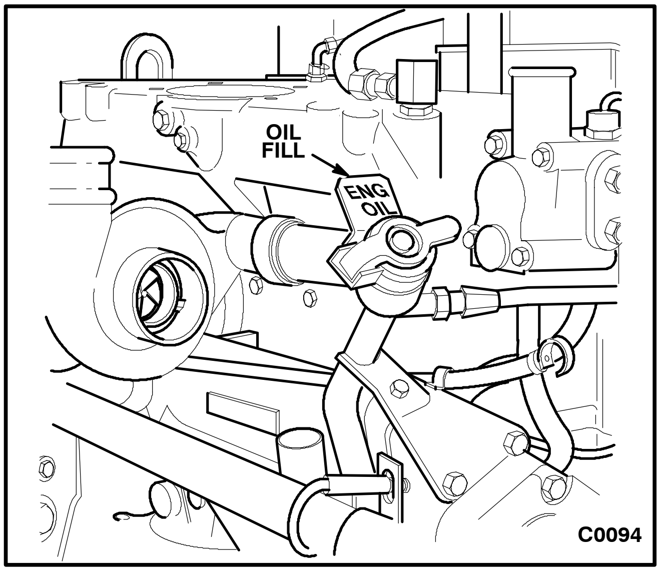


Figure 3. Oil Fill Tube

All diesel engines require heavy-duty lubricating oils. Basic requirements of such oils are lubricating quality, high heat resistance and control of contaminants.

The reduction of friction and wear by maintaining an oil film between moving parts is the primary requisite of a lubricant. Film thickness and its ability to prevent metal-to-metal contact of moving parts is related to oil viscosity. **The only lubricating oil recommended for Caterpillar 3176B and C-10 diesel engines is the API Service Code CE or CF-4 - SAE 15W-40.**

Temperature is the most important factor in determining the rate at which deterioration or oxidation of the lubricating oil will occur. The oil should have adequate thermal stability at elevated temperatures, thereby precluding formation of harmful carbonaceous and/or ash deposits.

The piston and compression rings must ride on a film of oil to minimize wear and prevent ring seizure. At normal rates of consumption, oil reaches a temperature zone at the upper part of the piston where rapid oxidation and carbonization can occur. In addition, as oil circulates through the engine, it is continuously contaminated by soot, acids, and water originating from combustion. Until they are exhausted, detergent and dispersant additives aid in keeping sludge and varnish from depositing on engine parts. But such additives in excessive quantities can result in detrimental ash deposits. If abnormal amounts of insolubles form, particularly on the piston in the compression ring area, early engine failure may result.

Oil that is carried up the cylinder liner wall is normally consumed during engine operation. The oil and additives leave carbonaceous and/or ash deposits when subject to the elevated temperatures of the combustion chamber. The amount of deposits is influenced by the oil composition, additive content, engine temperature and oil consumption rate.

SYNTHETIC OILS

Synthetic oils may be used in Caterpillar 3176B engines, provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils. Synthetic oils offer improved low temperature flow properties and high temperature oxidation resistance.

Product information about synthetic oils should be reviewed carefully. Performance additives often respond differently in synthetic oils. The use of synthetic oil does not permit extension of recommended oil drain intervals.

LUBRICATING OIL SPECIFICATIONS

Oil quality is the responsibility of the oil supplier. (The term “oil supplier” is applicable to the refiners, blenders and rebranders of petroleum products, and does not include distributors of such products.)

There are many brands of commercial crankcase oil marketed today. Obviously, engine manufacturers or users cannot completely evaluate the numerous commercial oils. The selection of a suitable lubricant in consultation with a reliable oil supplier, observance of his oil drain recommendations (based on used oil sample analysis and experience) and proper filter maintenance, will provide the best assurance of satisfactory oil performance.

Lubricating Oil Recommendation

API Service Code Classification	Military Specification	SAE Grade
CF-4		15W-40
CE		15W-40

SAE 15W-40 grade oil is recommended in the Caterpillar 3176B and C-10 diesel engines. The expected ambient temperatures and engine cranking capability must be considered by the owner-operator when selecting the proper grade of oil.

NOTE: Monograde oils should not be used in these engines regardless of API Service Classification.

The Caterpillar 3176B and C-10 engines have given optimum performance and experienced the longest service life with the following oil performance levels having the following ash and zinc limits: The sulfated ash limit (ASTMD-874) shall not exceed 1.0% by weight, except lubricants that contain only barium detergent-dispersant salts where 1.5% by weight is allowed. The zinc content, as zinc diorganodithiophosphate, shall be a minimum of 0.07% by weight.

Lubricants meeting specification MIL-L-46167 are used in Alaska and other extreme sub-zero locations. Generally they may be described as 5W-20 multigrade lubricants made up of synthetic base stock and having low volatility characteristics. Although they have been used successfully in some severe cold regions, they are not considered as desirable as SAE 15W-40 with auxiliary heating. For this reason, they should be considered only where engine cranking is a severe problem and auxiliary heating aids are not available on the engine.

POLICY ON LUBRICANT ADDITIVES

MCI does not recommend or support the use of any supplementary lubricant additives. These include all products marketed as top oils, break-in oils, graphitizers and friction reducing compounds.

> **NOTE:** MCI warranty applicable to Caterpillar 3176B and C-10 diesel engines provides in part that the provisions of such warranty shall not apply to any engine unit which has been subject to misuse, negligence or accident. Accordingly,malfunctions attributable to neglect or failure to follow the manufacturer's fuel or lubricating recommendations may not be within the coverage of the warranty.

SERVICE AND INSPECTION INTERVALS

Generally, the service intervals noted in the Caterpillar Operation and Maintenance Manual are minimum requirements to keep the engine warrant valid. Engine conditions may vary depending on the service environments from one coach to another, therefore, maintenance schedules should be formulated with the specific coach's service conditions in mind.

A suggested preventive maintenance practice includes a regularly scheduled testing of fuel and lubricating oils by either the oil supplier or an independent testing laboratory. Your oil supplier knows the physical properties of his products and maintains laboratories that can determine practical oil drain intervals. Request a check of oil samples and a report of there results for each engine's service conditions if different.

ENGINE MOUNTS

The engine is mounted to the engine cradle with four sets of round molded rubber and steel mounts (isolators). The two rear mounts attached to strut mount bracket on each side of the flywheel housing (Figure 4) and two front mounts attached to the plate brackets on each side of the crankshaft (Figure 5). The mounts should be inspected every 24 months or 60,000 to 96,000 miles, whichever comes first, and replaced if necessary using the following procedure.

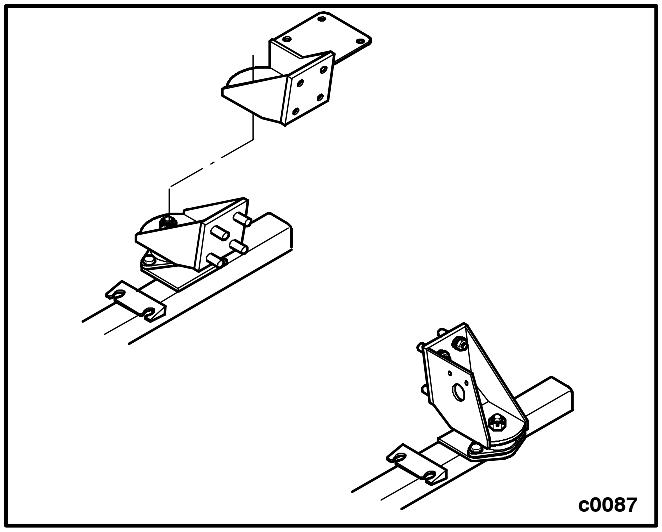


Figure 4. Rear Mount

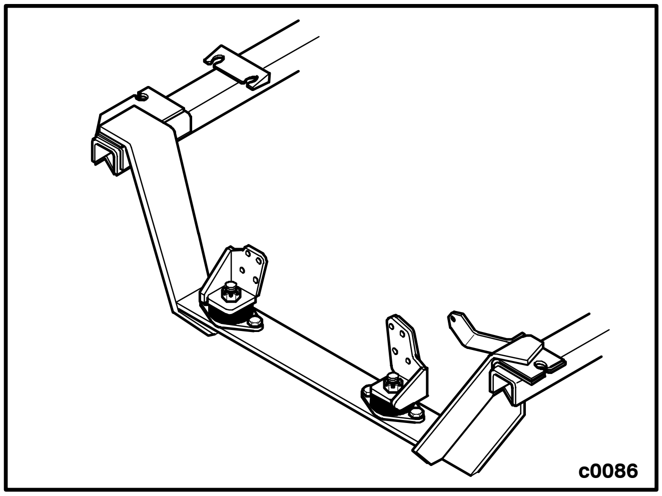


Figure 5. Front Mount

1. Unfasten and remove the damaged mount's center bolting, and loosen all other mount fasteners to allow its removal.

2. Position jack under engine and lift until bracket is clear and mount can be removed.

3. Position new mount under bracket, and slide center bolt through mount.

> **NOTE:** When replacing mount loosely tighten flange bolts to keep mount from moving on cradle while engine is being lowered.

4. Gently lower engine down onto engine craddle to set mount correctly onto their brackets, and hand tighten with full weight of engine bearing on cradle assembly.

⚠ CAUTION ⚠

Improper installation of the motor mounts can contribute to excessive engine vibration. When new mounts are installed, mount bolts should be left loose until engine can be run for a short period of time. If engine is accelerated a few times, the rubber mount will find its correct position and then mount bolts can be torqued and cotter keys installed.

ELECTRONIC ENGINE CONTROL SYSTEMS

GENERAL DESCRIPTION

Generally speaking most diesel engine electronic control systems operate approximately in the same manner. The systems receive, process and store information from sensors located throughout the engine and other related components. Input from these and other devices determines the command signals issued to maintain the engine's proper environmental and economic operation.

The systems are responsible for the storage and retrieval of vital engine information, the processing of received data and the transmittal of command signals that will achieve correct engine functions relating to operation. The systems can be interconnected to other electrically or electronically controlled components such as transmissions and throttle devices. The following is a list of functions or tasks that a typical engine control system should address. Control of the engine's fuel injection function (i.e., timing of and fuel metering), including transient fuel control (smoke control). Communication with the transmission control system. Monitoring of rated speed and power, torque shaping, engine governing, cold start logics, engine oil, intake air and coolant temperatures.

The systems also have protection circuits that reduce power and eventually shut down the engine completely in the event of a potentially damaging engine condition, such as low oil pressure, low coolant level or high engine temperature. The systems should incorporate a self-diagnostic feature, and may identify a fault condition or potential problem by illuminating a telltale light and/or an audible alarms. Fault codes identifying failed components are logged into the system's ECM memory for later readout by maintenance personnel.

The specific system that is covered by this sub-section is the Caterpillar PEEC III and ADEM II/III (C-10 & C-12) electronic engine control systems.

NOTE: For convenience this write-up may reference other engine manufacturers' terminology and/or illustrations where applicable to describe the components.

COMPONENTS

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Module (ECM) also known as the personality module is the microprocessor-controlled electronic monitoring and storage unit for an engine control system. The ECM unit mounts on the engine in back of the fuel filter (Figure 6).

The ECM can identify problem conditions within the engine by comparing input from the various sensors to a set of parameters (calibration and design data) stored within the ECM. After processing the input the ECM sends high current command pulses to the injector solenoids to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder.

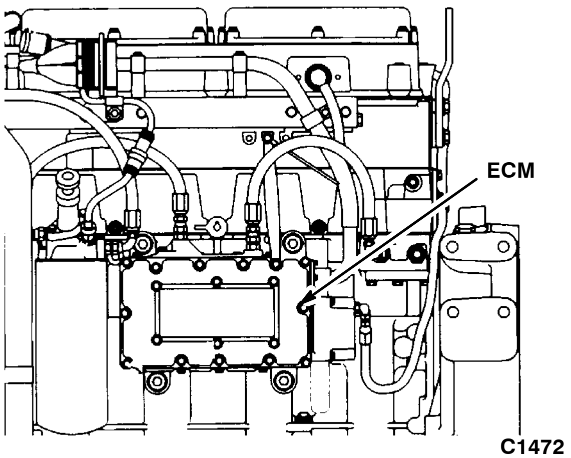


Figure 6. Electronic Control Module

NOTE: There are no user-serviceable parts within the ECM. If it is determined that the ECM is defective, it must be replaced in its entirety.

The ECM is factory programmed and is determined by a specific engine/transmission/tire size and axle ratio combination. Reprogramming will be required for any change within a combination.

Heat generated by the ECM on 3176B engine installations is dissipated via an internal heat exchange process. Fuel from the fuel tank flows through the body and absorbs heat from the unit.

VEHICLE SPEED SENSOR (VSS)

The Vehicle Speed Sensor (VSS) is located at the transmission output shaft and provides input to the ECM regarding vehicle speed.

The Vehicle Speed Buffer (VSB) was use on all 3176B engine installations to enhance the VSS input to the ECM. Alternate speed sensing input may have been obtained through a road speed generator on earlier model coaches, and utlized the VSB module.

NOTE: The remote mounted vehicle speed buffer was integrated with the ECM on C-10 & C-12 engines.

VEHICLE INTERFACE MODULE (VIM)

Some transmission's links to the engine control system's ECM requires a Vehicle Interface Module (VIM). This interface enables engines and transmissions of different manufacture to communicate vehicle speed from a VSS and other related information. Refer to Serial Communication Interface (SCI) standards SAE J-1708 and J-1587. The VIM is typically located in the A/C & ATEC/WTEC junction box.

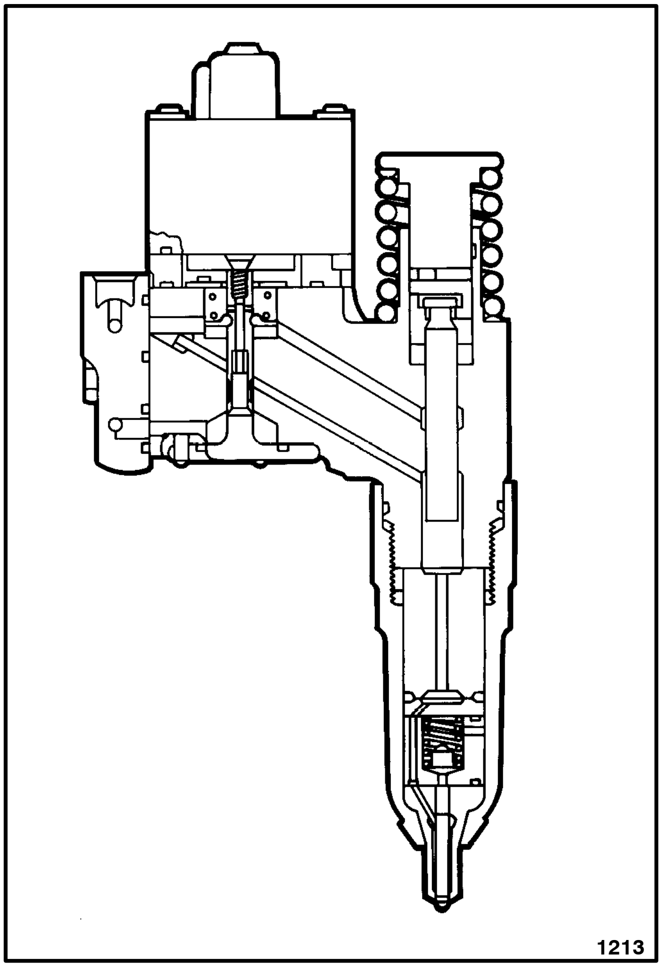


Figure 7. Electronic Unit Injector

ELECTRONIC UNIT INJECTORS (EUI)

The Electronic Unit Injectors (EUI) (Figure 7) are electronically controlled solenoid operated fuel injectors mounted into the cylinder head above each cylinder. The solenoid-operated poppet valve on each EUI performs injection timing and fuel metering functions.

Pressurization of fuel inside the injector occurs by a conventional cam-operated plunger. When the solenoid valve on the EUI is closed, fuel is pressurization and injection is initiated at beginning of injection (BOI) (Figure 8).

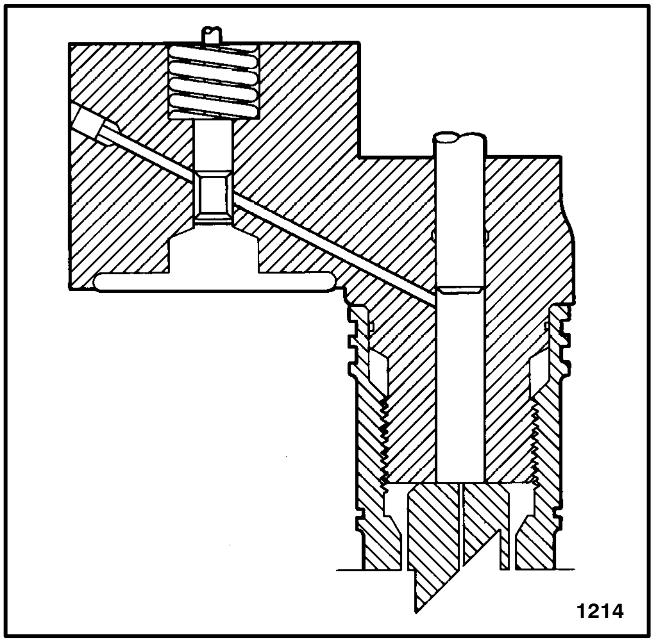


Figure 8. Solenoid Valve (Closed)

When the solenoid valve on the EUI is open pressure decreases and fuel injection ends (Figure 9). The duration of solenoid valve closure (pulse width) determines quantity of fuel injected.

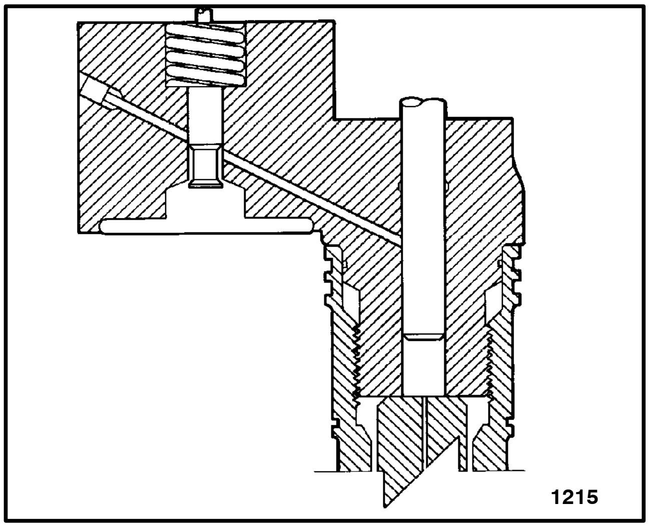


Figure 9. Solenoid Valve (Open)

SPEED/TIMING SENSOR (STRS)

The Speed/Timing Reference Sensor (STRS) (Figure 10) is located at the upper rear of front gear case behind the camshaft gear. A pulse wheel on the camshaft gear causes the sensor to send timing pulses to the ECM. The STRS provides one signal per cylinder at its proper firing position.

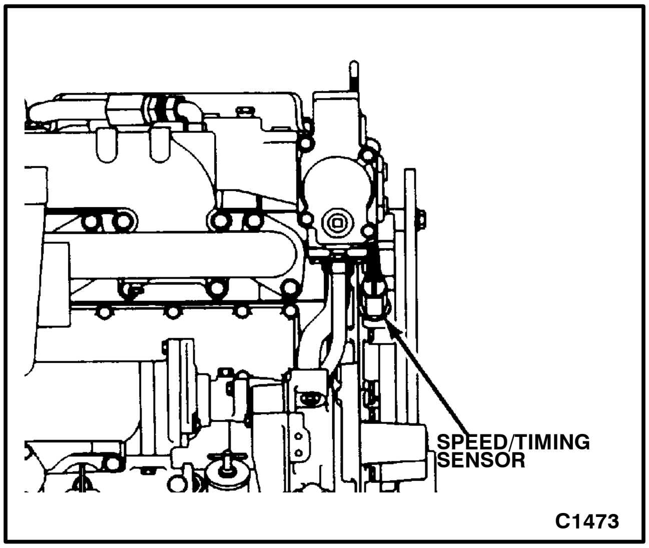


Figure 10. Speed/Timing Reference Sensor

SYNCHRONOUS REFERENCE SENSOR (SRS)

The Synchronous Reference Sensor (SRS) is located below the crankshaft in the engine block front. The SRS provides one signal per revolution of the engine crankshaft.

THROTTLE POSITION SENSOR (TPS)

The Throttle Position Sensor (TPS) (Figure 11) is located in the electronic foot pedal assembly (EFPA) and converts the throttle position into a signal usable by the ECM. This sensor, in effect, replaces the mechanical linkage from the accelerator treadle to the engine.

Because of different language protocols between the Caterpillar and ATEC transmissions, a different TPS installation (P/N 13L-7-112) was used on earlier model coaches with Caterpillar and Allison HT-746 powertrain combinations. This Throttle Position Sensor was located on a mechanical linkage throttle plate, and actuated from the accelerator by cable.

NOTE: The cable actuated TPS was no longer needed with WTEC transmissions.

BOOST PRESSURE SENSOR (BPS)

The Intake Manifold Boost Pressure Sensor (BPS) (Figure 12) is located on the rear of manifold or adjacent to the manifold temperature sensor. The TBS provides a signal to the ECM during engine operation for transient smoke control.

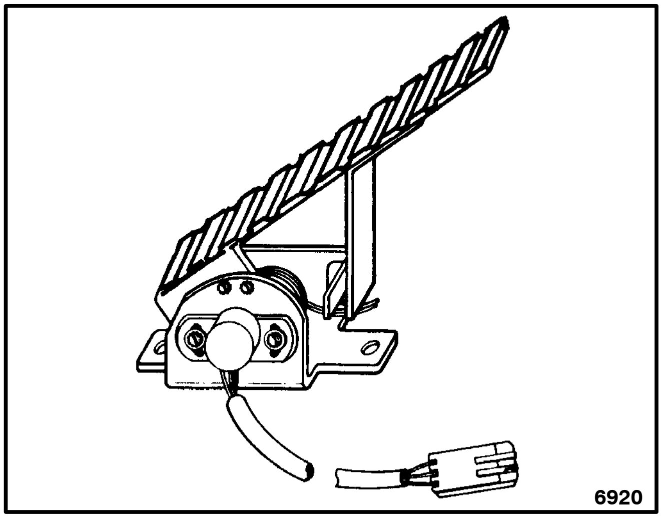


Figure 11. Throttle Position Sensor

MANIFOLD TEMPERATURE SENSOR

The Intake Manifold Temperature Sensor (IMPS) is located in the intake manifold (Figure 12). This sensor provides a signal to the ECM for the Charge-Air-Cooling system.

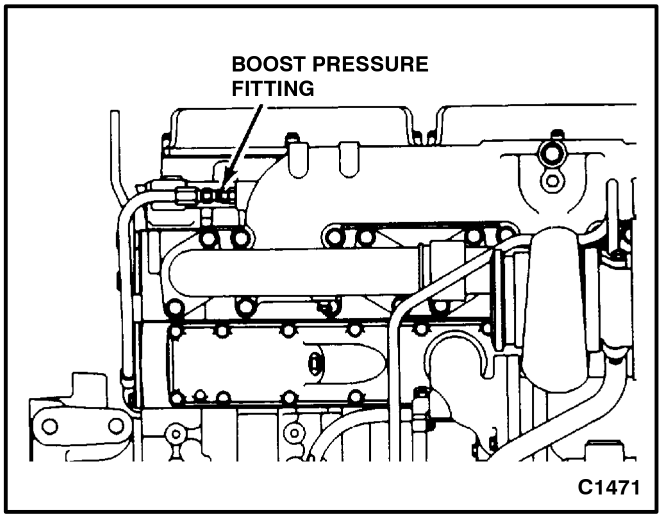


Figure 12. Intake Manifold Sensors

OIL PRESSURE SENSOR (OPS)

The Oil Pressure Sensor (OPS) (Figure 13) is located in the engine oil gallery directly under the fuel filter. The OPS monitors oil pressure in the engine and, if engine oil pressure falls below a specified minimum value the ECM should alert the driver by illuminating the amber “CHECK ENGINE” light and/or the red “STOP ENGINE” light. The (ECM) will sound an audible alarm and initiate the engine protection (power/shut-down) sequence.

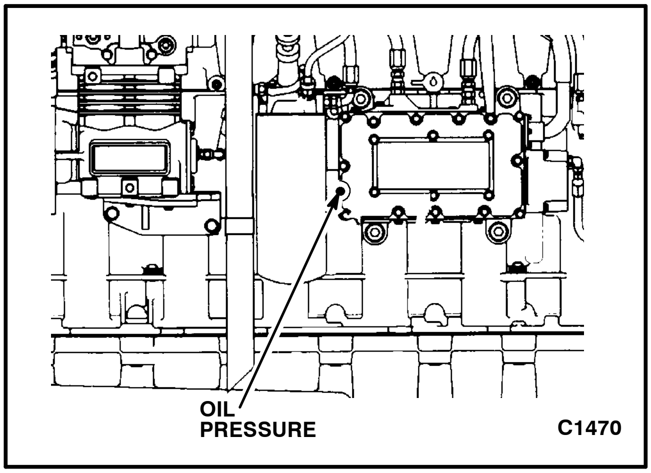


Figure 13. Oil Pressure Sensor

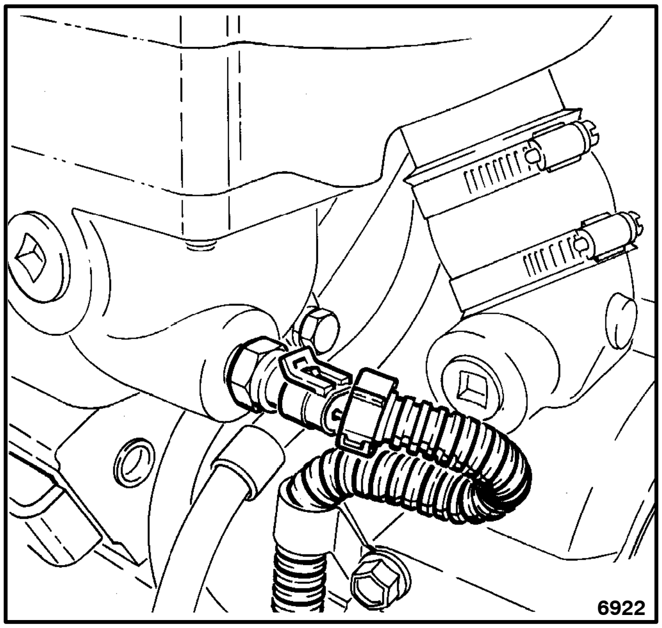


Figure 14. Coolant Temperature Sensor

COOLANT TEMPERATURE SENSOR (CTS)

The Coolant Temperature Sensor (CTS) monitors engine coolant temperature, and is mounted in the front of the engine thermostat housing (Figure 14). Additionally, the CTS input may be used in the cold start logic feature of some electronic control systems ECM.

If the coolant temperature exceeds the specified maximum the ECM will illuminate the amber “CHECK ENGINE” telltale warning light. If the coolant temperature exceeds the ECM shut-down parameters the red “STOP ENGINE” telltale warning light will illuminate. The ECM will initiate the engine protection sequence.

NOTE: For more information on the engine protection sequence see “Diagnostic” later in this sub-section.

COOLANT LEVEL SENSOR (CLS)

The Coolant Level Sensor (CLS) assembly sends a constant signal to the ECM to indicate coolant level in the engine’s cooling system. The vehicle manufacturer supplied CLS probe is located near the bottom of the radiator’s surge tank, and monitors the coolant level (Figure 15).

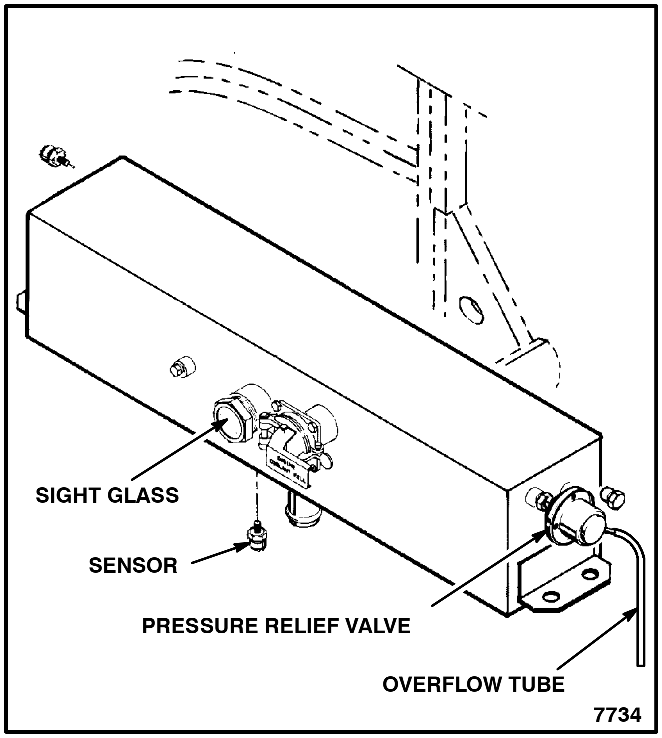


Figure 15. Coolant Level Sensor

FUEL TEMP/PRESSURE SENSOR

The Fuel Temperature (front) and Fuel Pressure (rear) Sensors (FTS) (FPS) are located on the fuel filter block. These sensors monitors the fuel temperature and pressure to adjust ECM fuel rate calculations for hot or cold weather fuel metering (Figure 16).

MAINTENANCE

DIAGNOSTICS

The Caterpillar PEEC III and ADEM II/III (C-10 & C-12) electronic engine control system diagnostics feature can be separated into three areas: Engine Performance Diagnostics, Self Diagnostics and Engine System Protection.

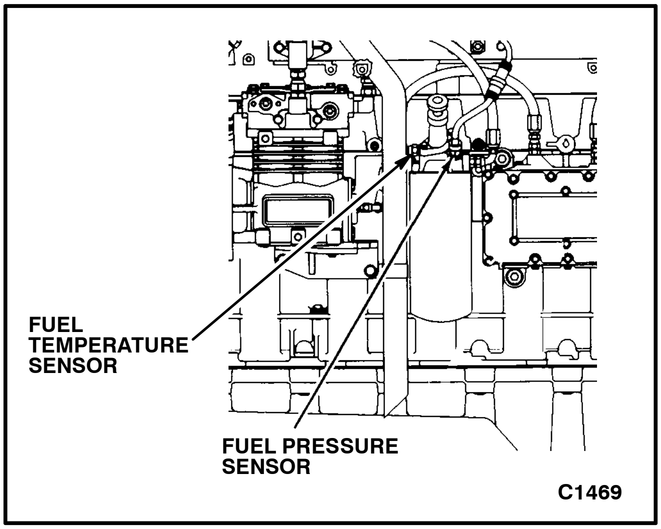


Figure 16. Fuel Temperature/Pressure Sensors

Engine Performance Diagnostics

The PEEC III and ADEM II/III systems continuously monitor various sensors and makes adjustments to injector timing and fuel quantity (metering) input, depending on EEPROM programming and sensor input, to provide optimum performance and minimal acceleration smoke under all operating conditions. Cold weather starting is improved by matching the fuel input and timing to the ambient air temperature.

System Self-Diagnostics

The system continuously monitors itself and all related wiring for faults. If a fault is detected, the “CHECK ENGINE” and/or “STOP ENGINE” light(s) will illuminate (depending on the severity of the fault), and if the fault is in the main microprocessor, a backup microprocessor takes control.

When the system is under the control of the backup microprocessor the engine will continue to function normally. However, fuel injector control logic is based on the following sensor input information:

1. Throttle Position Sensor (TPS).
2. Vehicle Speed Sensor (VSS).
3. Coolant Temperature Sensor (CTS).
4. Intake Manifold Sensors.

All other sensor input is ignored and a generic set of calibration data is substituted which may degrade engine performance while in the backup mode. Auxiliary features which remain operational during backup mode are the engine protection feature.

Engine Protection (With Shutdown Sequence)

When the engine protection feature is initiated the amber “CHECK ENGINE” and red “STOP ENGINE” telltale warning lights on the left hand tell-tale cluster are illuminated (Figure 17) A fault code is logged into the ECM’s memory and the following power reduction sequence is begun.

A. Five seconds after fault detection power is reduced to 84% of current throttle.

B. Ten seconds after fault detection power is reduced to 68% of current throttle.

C. Fifteen seconds after fault detection power is reduced to 53%of current throttle.

D. Seventeen seconds after fault detection power is reduced to 40% of current throttle. No further reduction of power occurs past 40% throttle.

NOTE: This should give the driver enough power to move the coach to a point of safety where it can be shut down.

E. After thirty seconds all fuel is cut off completely.

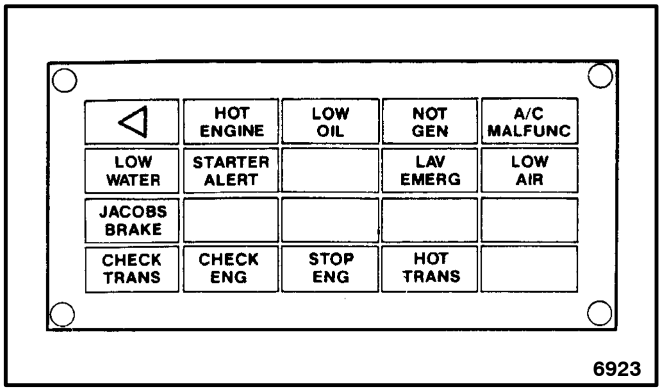


Figure 17. Telltale Panel

If the engine protection feature is triggered, it will remain active until the fault goes away or the system is reset. The system can be reset by safely parking the coach, shutting off the ignition, waiting ten seconds and then restarting the engine.

If the fault was temporary, the indicator lights on the telltale panel will go out and normal operation will resume. A fault code will be logged in memory until the memory is cleared. The memory may be cleared by use of a Digital Diagnostic Tool (DDT). The fault may also be cleared by restarting the engine a number of times without the fault being relogged.

If the fault remains after the engine is restarted, the problem is not temporary, and maintenance or repair of the problem is indicated.

TROUBLESHOOTING

The replacement of any internal engine components should be based on diagnostic codes indicating faulty components. Refer to the applicable system’s troubleshooting manual and/or the appropriate instruction manual for the diagnostic data reader being used for complete information on diagnosis of components.

Troubleshooting the system can be divided into the following two areas. The first being mechanical checks such as wiring and connector problems. The second being the proper use of the DDT, in interpreting of the logged codes.

Mechanical Checks

Mechanical checks involve checking all wiring and connectors for proper connection, dirty or corroded terminals and visual inspection of components for loose, damaged, or missing parts.

All wiring is Teflon coated with crimp-type connectors. Solder-type connectors are not used nor recommended on wiring because normal vibration will cause the solder connection to fail in time.

Diagnostic Data Reader

The Digital Diagnostic Tool (DDT) is a hand-held electronic device that can be connected to the data link for accessing and review of logged fault codes (Figure 18).

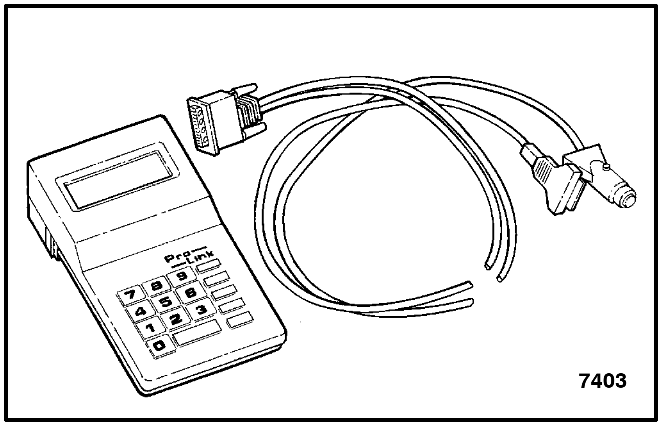


Figure 18. Digital Diagnostic Tool

The Diagnostic Data Link (DDL) connectors are installed on the coach and enable the user to connect a DDR to access and interpret the fault codes logged into the ECM's memory and/or operational data. These DDL connectors are located in the A/C & ATEC/WTEC junction box, or under the dashboard near the steering column.

NOTE: The 3176B engines also had a remote DDL on the engine harness near the ECM.

The DDT should be able to electronically troubleshoot all system components and related wiring. Operation of the DDT should be in accordance with the "Digital Diagnostic Tool User's Manual". Refer to the instruction book provided for complete diagnostic procedures.

If a DDT is not immediately available, the fault codes logged in the ECM's memory can be interpreted by use of the Cruise Control switch on the lower LH switch panel. Position the switch on and note the flashing light on the telltale cluster panel. The light should flash a sequence of codes which identify the faulty component or system. For example, if the light flashes once, then pauses and flashes two more times, this would indicate a fault code 12, which is interpreted as a problem with the coolant level sensor.

Refer to the Caterpillar Troubleshooting Guide for a complete listing of the fault codes and their meanings.

NOTE: Read the "WELDING CAUTION" in this books introduction before beginning any welding procedures on coaches equipped with an electronic engine control system.

JACOBS ENGINE BRAKE SYSTEM

GENERAL DESCRIPTION

The Jake Brake™ engine brake feature effectively converts a power producing diesel engine into a power absorbing air compressor.

Generally, all Jake Brake™ engine brake installations operate in much the same manner. The basic difference between engine brake function is the number of brake modules (one per cylinder) utilized in the installations. The engine brake feature may be selected for either a half-force, two thirds or a full-force application depending on the amount of power to be absorbed.

The engine brake mechanically opens the cylinder exhaust valves near the top of the normal compression stroke, and releases the compressed cylinder charge to create an exhaust blowdown. Blowdown of the compressed air to atmospheric pressure prevents return energy for engine operation on an expansion stroke, the effect being a net energy loss since work done in compressing the cylinder charge is not utilized.

COMPONENTS

There are very few components in a typical engine brake installation. Some of the main components are the housing assembly, the selector switch, wire harness and any related switches associated with other equipment.

HOUSING ASSEMBLY

The main component of the engine brake is the housing assembly, (one per cylinder). The housing is mounted atop the cylinder head above each set of exhaust valves and the injector.

The housing assembly includes the master and slave pistons, the control valve with ball check, oil accumulator, the solenoid valve, and internal oil passages.

SELECTOR SWITCH

The selector for the engine brake feature is a three position type switch, located on the left hand switch panel.

OPERATION

The following is a simplified version of the operational sequence for a typical engine brake cycle (Figure 19).

A. Energizing the engine brake solenoid valve permits engine lube oil to flow under pressure through the control valve into the master and slave piston circuit.

B. Oil pressure causes the master piston and its extension to move down, coming to rest on the injector rocker clevis.

C. The injector rocker clevis begins upward travel (as in normal injection cycle) forcing the master piston upward and creating a high pressure oil flow to the slave piston. The ball check valve in the control valve imprisons high pressure oil in the master slave piston system.

D. The slave piston under the influence of the high pressure oil flow moves down momentarily opening the exhaust valve while the engine piston is near its top dead center position releasing compressed cylinder air to the exhaust manifold.

E. Compressed air escapes to atmosphere completing a compression braking cycle.

To retard a coach on a downgrade using the Jake Brake™, the operator selects a gear which will provide a balance between engine speed and road speed. If the engine speed exceeds maximum rated rpm, for a desired road speed, a higher gear can be selected, or intermittent use can be made of the vehicle service brakes.

The selection of successively lower gears will generally allow complete control of the vehicle by the Jake Brake™ leaving the vehicle service brakes in reserve to be used for emergency stops. After some practice most drivers will know what combination of gears will give the best results over a particular route.

MAINTENANCE

The Jacobs engine brake installations are relatively trouble-free. However, inspections to and adjustments of the installations along with parts replacement will need to be made periodically. Use the following procedures to access the installations when needed.

Note: Caterpillar installations have engine brake modules on all cylinders.

SOLENOID VALVE REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 20)

Note: Most engine brake installations will allow the solenoid valves to be removed from the housing while housing is still attached to the cylinder head.

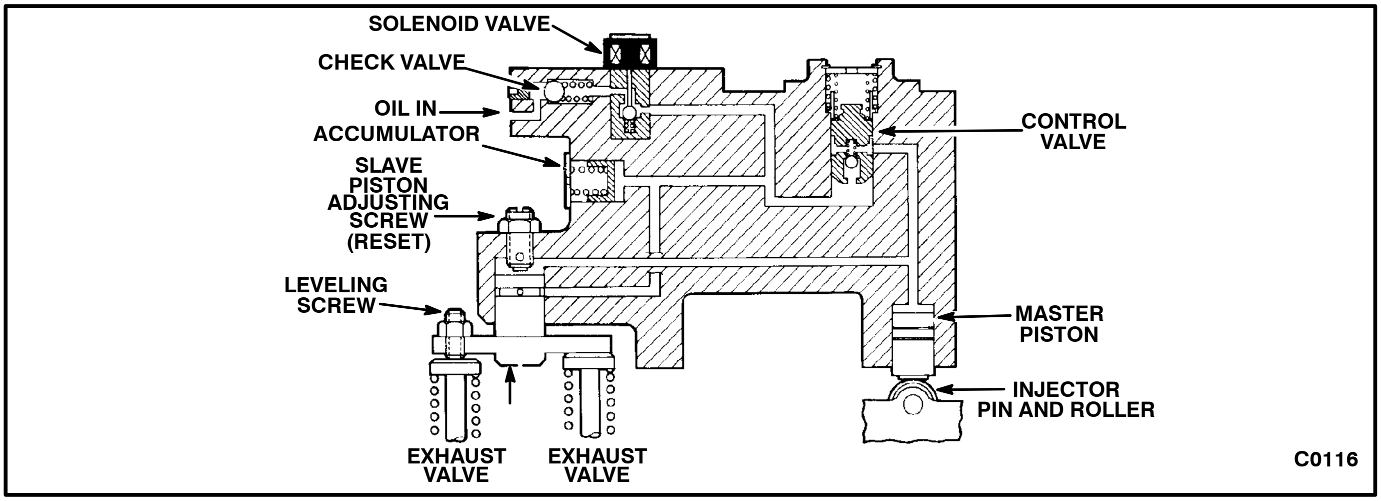


Figure 19. Engine Brake Operational Schematic (Caterpillar)

1	RETAINING RING
2	WASHER
3	STOP SPRING
4	SPRING
5	COLLAR
6	CONTROL VALVE
7	SOLENOID VALVE
8	SEAL RING, UPPER
9	SEAL RING, CENTER
10	SEAL RING, LOWER
11	SPRING
12	PISTON, ACCUMULATOR
13	RESET SCREW ASSY, HEX NUT
14	SCREW
15	FLAT SPRING
16	FLAT SPRING
17	MASTER PISTON
18	ADJUSTING SCREW
19	HEX NUT
20	SLAVE PISTON
21	BRIDGE
22	TORSION SPRING
23	BUTTONHEAD SCREW

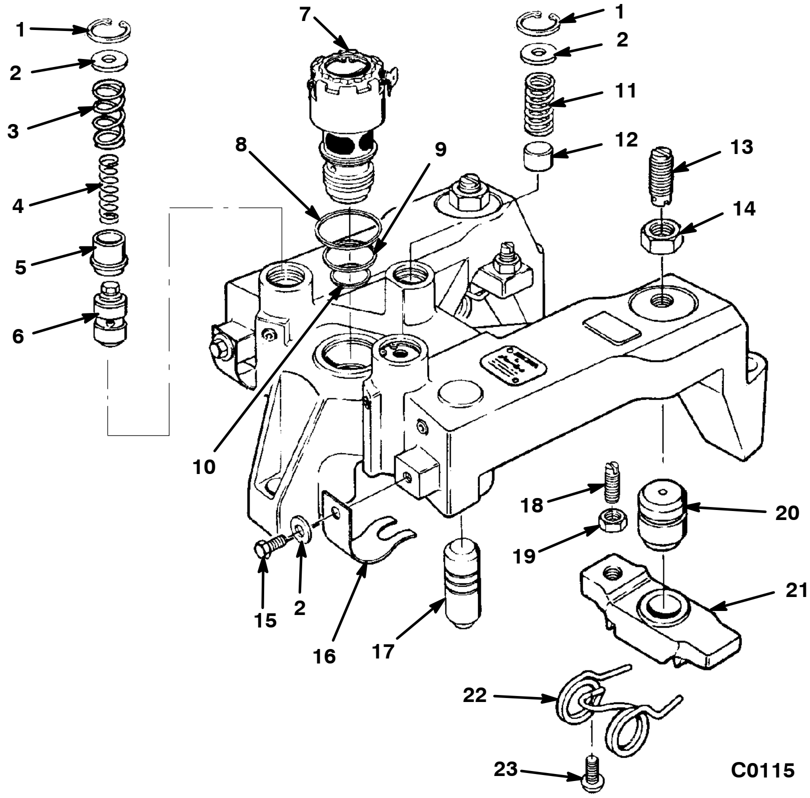


Figure 20. Engine Brake Housing Assembly (Caterpillar)

1. Remove the valve cover from the engine.
2. Disconnect the wiring from the solenoid valve.
3. Using 7/8 inch socket and extension, unscrew solenoid valve (Figure 21).

⚠ CAUTION ⚠

Do not disassemble or tamper with the solenoid valve. The solenoid valve contains no serviceable parts.

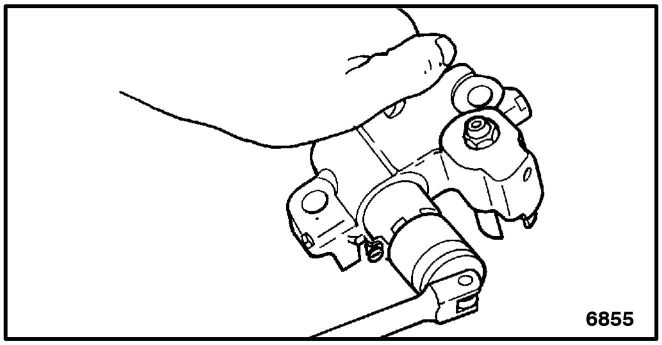


Figure 21. Remove Solenoid Valve

4. Remove and discard the three rubber O-ring seals (Figure 22) the lower ring stays in the bottom of housing solenoid bore, remove with a piece of wire.

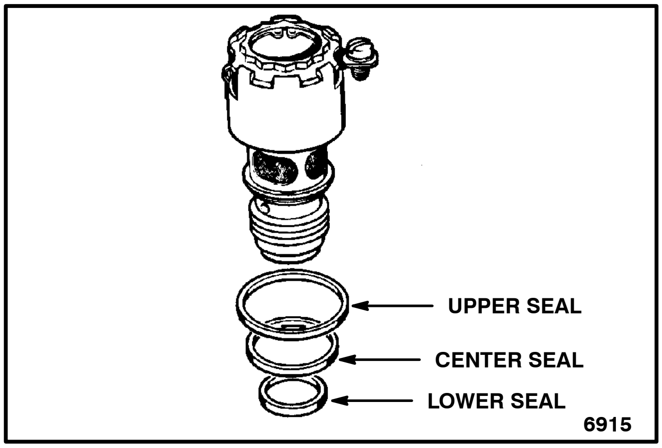


Figure 22. Remove Solenoid Valve Seals

5. Clean the solenoid valve with approved cleaning solvent. Use a brush to clean the oil screen. Dry the valve with compressed air.
6. Clean the solenoid valve bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.
7. Coat the new solenoid O-ring seal with clean lube oil before installing.
8. Install the upper and center O-ring seals on the solenoid body, and the lower seal ring into the bottom of the solenoid bore in the housing (Figure 23).

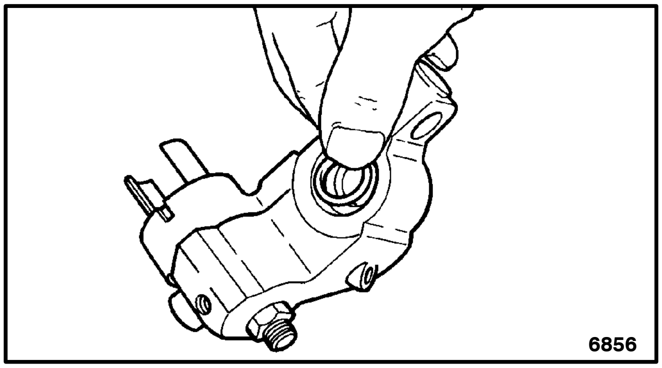


Figure 23. Install Solenoid Valve Seals

9. Be sure the seals are seated properly and carefully screw the solenoid into housing without unseating the seals. Torque the valve to 60 in-lbs (7 N·m). Be careful not to twist the seals while installing.

CONTROL VALVE REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 20).

⚠ WARNING ⚠

Remove the control valve retaining rings carefully. Control valves are under load from the control valve springs. Use care in removing to avoid personal injury.

1. Remove the Jake Brake housing assembles from the cylinder head by reversing the system installation procedure for housings.
2. Press down on the control valve washer using an appropriate rod to relieve spring pressure
3. Remove retaining ring using retaining ring pliers.
4. Continue by following steps 4 through 8 of the previous procedure.

SLAVE PISTON REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 20).

1. Remove the capscrew and torsion spring that retains the slave piston and bridge assembly.
2. Remove the bridge and piston from its bore.
3. Loosen the leveling screw locknut and remove the leveling screw from the bridge.
4. Continue by following steps 5 and 6 of the previous procedure.
5. Reinstall, via reverse procedure with the leveling screw toward the center of the housing.
6. Position the torsion spring with the ends over bridge grooves.
7. Install the spring capscrew and torque to 15 ft-lbs (20 N·m).

⚠ CAUTION ⚠

While tightening the screw on the torsion spring, push the sprig towards the slave piston assembly. Failure to do so may result in contact between the intake valve adjusting screw and torsion spring, resulting in serious engine damage.

MASTER PISTON REMOVAL

Note: Refer to the “Housing Components” illustration (Figure 20).

1. Remove master piston retaining spring capscrew from housing and slide piston out of its bore.
2. Remove, clean and inspect all components.
3. Clean the slave piston bore in the housing. Use clean paper towels. Never use rags, as they may leave lint and residue which can plug the oil passageways.
4. Lube the master piston and insert into bore. the piston should move freely without binding.
5. Reverse the procedure to assemble piston and torque to100 in-lbs (10 N·m).

SYSTEM INSTALLATION

Before beginning clean and remove the rocker covers. If the engine is equipped with an aluminum two piece valve cover, remove only the upper cover to access engine brake. Removal of the fuel supply and drain tubes may allow easier access. To remove the tubes loosen nuts on injector and risers at back of cylinder head Save all fuel tubing for reuse (Figure 24).

Note: Some procedures and/or steps herein will be specifically addressing the retrofitting of Jake Brakes™ to existing engines. These procedures and/or steps may not be applicable to normal maintenance tasks.

Brake Housing

Note: Some minor differences exist between these installations, i.e. housing configurations. Follow the Jacobs Brake™ installation booklet that matches the specific engine being fitted.

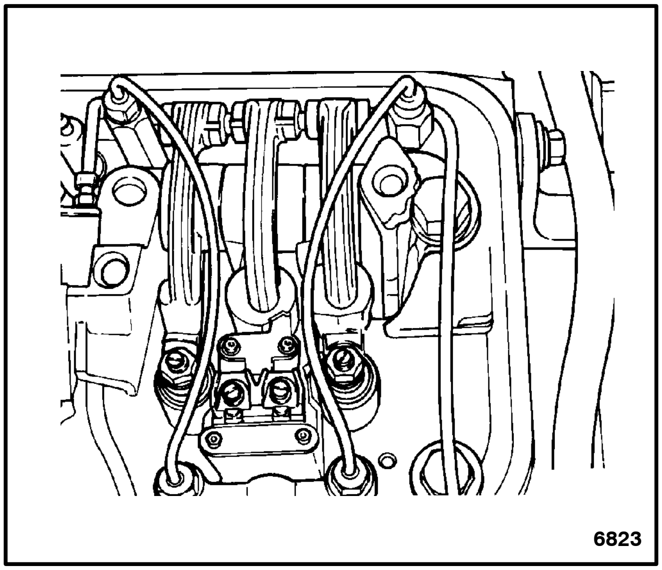


Figure 24. Removing Fuel Supply And Drain Pipes

If retrofitting Jake Brakes™ to existing engine, install the undercover wire harness before installing brake housings. See “Solenoid Valve Harness procedure that follows. Secure the harness to the spacer bars only after mounting housings.

1. Remove the two front bearing capscrews on the intake manifold side.

2. Insert the two housing spacer bars on the exhaust manifold side of the cylinder head with the “out” markings adjoining each other and facing the exhaust manifold.

3. Place the two engine brake housings over the rocker shafts and spacer bars with the solenoid valves toward the camshaft side of the engine.

4. Install a washer onto each of the housing capscrews and insert into the housing (3 capscrews per housing).

5. Before torquing housing capscrews, move the housing from side to side and position at midpoint of movement.

6. Torque the housing capscrews per the following sequence.

A. Tighten camshaft side capscrews to 40 ft-lbs (55 N·m) torque.

B. Tighten exhaust side capscrews to 40 ft-lbs (55 N·m) torque.

C. Repeat the above sequence and torque to 80 ft-lbs (110 N·m).

Solenoid Valve Harness

1. Remove the mounting flange cover for the EUI harness of cylinder head.

2. Insert the wires leads to the Jake Brake™ solenoid harness through the access holes in the grommet from outside in.

Note: Once the wires are inserted through the grommet, they cannot be removed due to the terminal’s locking tangs.

3. Install the solenoid harness along side of the injector harness, with its end connector located outboard of the last rear harness standoff.

4. Insert the wire lead’s pin housing into the undercover solenoid harness’ connector.

5. Install pins to the ends of the wire leads, and insert the wire lead’s pins into the housing.

Note: Do not reverse the wire lead to harness connection color codes, or improper engine brake sequencing will occur.

6. Bend all of the electrical terminals at the injectors upwards about 90 degrees to provide clearance for the engine brake housings.

Clutch Microswitch

A Jake Brake™ clutch microswitch is used with the standard transmission installations. The switch is normally closed when clutch is disengaged (pedal out) to permit Jake Brake™ operation. When clutch is engaged (pedal in) the Jake Brake™ circuit is broken and Jake Brakes™ are momentarily off (during downshift).

The microswitch is mounted to the clutch pedal mounting bracket attached to the driver’s kick panel. (Figure 25). The proper positioning of the microswitch allows the switch to be activated during clutch pedal play before actual clutch disengagement occurs.

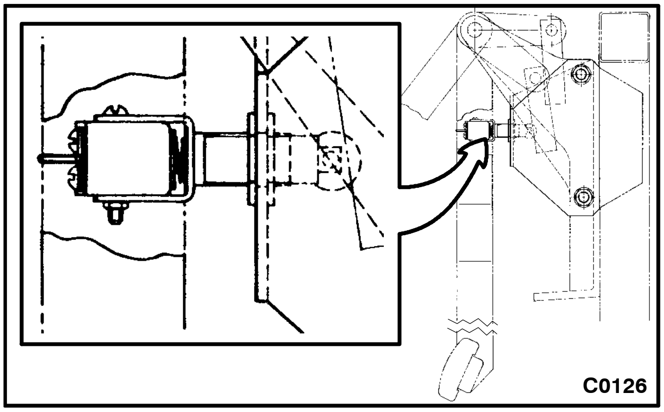


Figure 25. Clutch Microswitch Mounting

Positioning of the switch is done by means of the jamnuts which hold the switch to its bracket. Loosen and tighten these nuts to achieve the desired direction of movement of the switch towards or away from the clutch shaft lever.

When positioning the switch, avoid placing it so close to the lever arm that the switch contacts are damaged by excessive pressure.

Dash Mount Switch

The Jacobs engine brake switch is located in the lower center of the right-hand switch panel, to the right side of the driver (Figure 26).

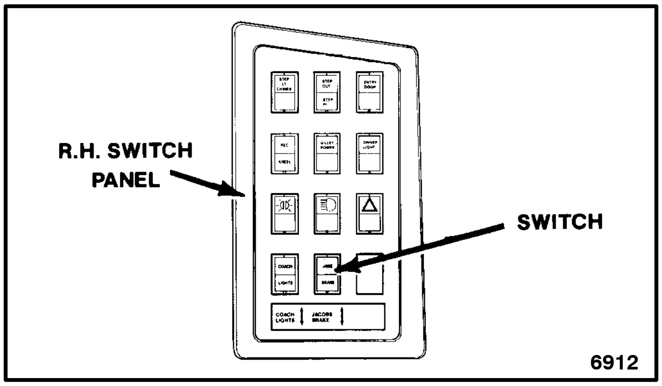


Figure 26. Jacobs Engine Brake Switch

The switch contacts are protected against arcing by a small diode connected between the load side solenoid valve switch terminals and ground. The engine brake must be connected to the load side terminal. Refer to the Jacobs Engine Brake wiring diagram in sub-section 7J.

Half or full operation of the engine brake may be selected by moving the switch on the dash to the intermediate position for operating half of the engine brakes, or by moving it to the upper position which brings both engines banks into operation.

When the switch is in the fully downward position, the engine brake is off.

Engine braking will not begin unless the driver's foot is removed from the accelerator pedal.

ADJUSTMENTS

The following are general adjustment procedures for setting the intake/exhaust valves, injectors and slave piston clearance.

For specific information on settings and tools consult the engine manufacturer's service publications and/or the engine data plate located on the engine.

Fuel Injector Height

1. Rotate the engine until any one of the injector followers has just begun its downward stroke and note the number of this cylinder.

Note: The Timing Circle Method may be used to adjust engine injectors and valves.

2. Place the injector timing gauge in the hole provided in the top of the injector body with the flat of the gauge toward the injector follower.

3. The flat of the injector gauge should just pass over the top of the injector follower. If it does not, loosen the push rod locknut and turn the push rod to obtain the proper clearance.

4. Hold the push rod and tighten the locknut to 35 ft-lbs (47 N·m). Adjust all the remaining injectors in the same manner as outlined above. Follow the firing order for the specific engine being adjusted.

Exhaust Valves

1. Rotate the crankshaft until the injector follower is fully depressed on the cylinder to be adjusted.

2. Loosen the exhaust valve rocker arm push rod locknut.

3. Place a feeler gauge between the valve bridge and the valve rocker arm pallet. Adjusting the push rod to obtain a smooth pull on the feeler gauge.

Note: Checking and Setting feeler gauge dimensions can be found in the specifications at the end of this sub-section.

4. Remove the feeler gauge. Hold the push rod with a 5/16-inch wrench and tighten the locknut with a 1/2-inch wrench.

5. Check the clearance using the check dimensions for the specific engine.

OPERATIONAL CHECK

⚠ CAUTION ⚠

Always check the fuel system for leaks after injector or fuel pipe replacement and any time the fuel connections under the rocker cover are suspected of leaking. Failure to correct a serious fuel leak in the area can lead to dilution of the lube oil and bearing and/or cylinder wall damage.

After operating the engine for 20-30 minutes shut it off and remove the rocker covers. Inspect the lube oil puddles that normally form where the fuel connectors join the cylinder head and where the fuel pipes join the fuel pipe nuts.

If there is any leakage at a connection, the lube oil puddles will appear smaller or thinner than the puddles on connectors that are not leaking. Disassemble, inspect, and correct or replace

the suspect part (connector washer, connector, injector or jumper line). Test and reinspect.

Never remove any engine brake component with engine running. Personal injury may result.

1. The Jake Brake™ dash switch should be in the "OFF" position, (engine brake solenoid not energized).
2. Move the shift selector to "Neutral" with the clutch pedal released (clutch engaged)
3. Start the engine and allow to warm up for a few minutes.
4. Move the dash switch to the Half-Force braking position.
5. Accelerate the engine above idle and release throttle pedal.

Note: Only one bank should operate during engine deceleration and shut off just above idle speed.

Note: On non-electronically controlled engines, if the engine brake does not shut off before reaching idle speed or shuts off too early, reset the buffer screw adjustment.

6. Move the dash switch to the Full-Force braking position.
7. Accelerate the engine above idle and release throttle pedal.

Note: All engine brakes should operate during engine deceleration and shut off before reaching idle.

8. Depress the clutch pedal to open the contacts in the clutch switch. With the dash switch in Full-Force braking position, accelerate the engine and release the pedal. The engine brakes should not operate with the clutch disengaged (pedal depressed).

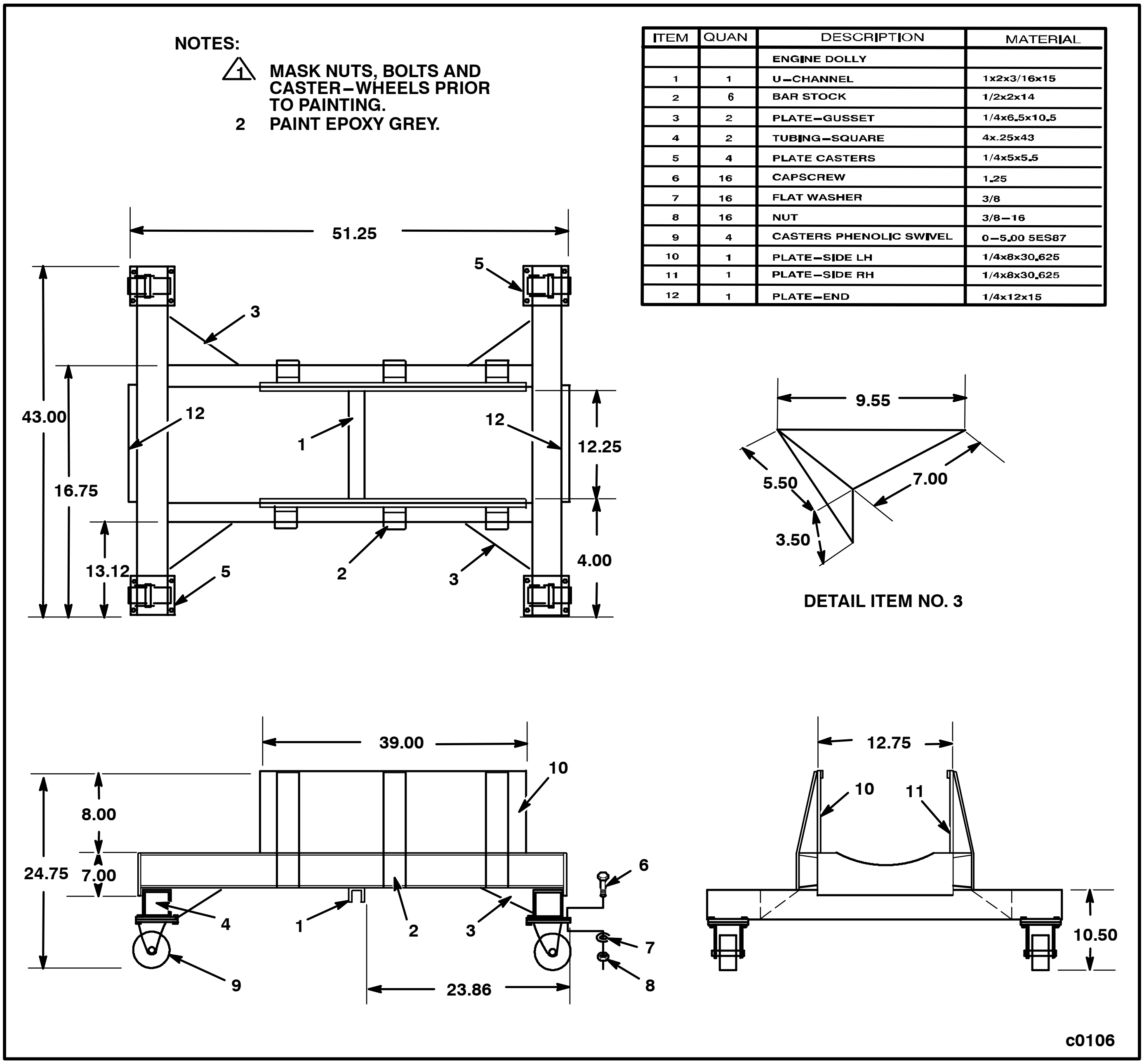
⚠ CAUTION ⚠

If any of the above conditions are not met, recheck all installation procedures for correctness.

9. Install rocker cover and gasket. Torque cover hold down bolts to 20 ft-lbs (27 N·m).

SERVICE TOOLS

MANY OF THE TOOLS LISTED IN THIS SECTION ARE SPECIALLY DESIGNED TO MEET THE NEEDS OF VARIOUS SERVICE OPERATIONS. THEY ARE AVAILABLE FOR PURCHASE THROUGH MOTOR COACH INDUSTRIES, SERVICE PARTS DIVISION AND UNIVERSAL COACH PARTS OR, WHERE PRACTICAL, MAY BE MANUFACTURED BY THE OPERATOR. IN THESE CASES, DRAWINGS ARE AVAILABLE UPON REQUEST.



NOTES:

1. MASK NUTS, BOLTS AND CASTER−WHEELS PRIOR TO PAINTING.
2. PAINT EPOXY GREY.

ITEM	QUAN	DESCRIPTION	MATERIAL
		ENGINE DOLLY	
1	1	U−CHANNEL	1x2x3/16x15
2	6	BAR STOCK	1/2x2x14
3	2	PLATE−GUSSET	1/4x6.5x10.5
4	2	TUBING−SQUARE	4x.25x43
5	4	PLATE CASTERS	1/4x5x5.5
6	16	CAPSCREW	1.25
7	16	FLAT WASHER	3/8
8	16	NUT	3/8−16
9	4	CASTERS PHENOLIC SWIVEL	0−5.00 5ES87
10	1	PLATE−SIDE LH	1/4x8x30.625
11	1	PLATE−SIDE RH	1/4x8x30.625
12	1	PLATE−END	1/4x12x15

51.25
5
3
43.00
12
1
12
12.25
16.75
13.12
5
2
3
4.00
9.55
5.50
7.00
3.50
DETAIL ITEM NO. 3
39.00
10
8.00
24.75
7.00
4
1
2
3
6
7
9
23.86
8
12.75
10
11
10.50
c0106

Figure 27. Engine Dolly (P/N 20-377)

MISCELLANEOUS ENGINE TORQUE VALUES

FOR COMPLETE ENGINE SPECIFICATIONS REFER TO THE APPROPRIATE CATERPILLAR ENGINE SERVICE MANUAL.

Front Motor Mount Center Bolts (Rear of Coach)	75-80 ft-lbs (100-110 N·m)
Rear Motor Mount center Bolts (Near Transmission)	110-125 ft-lbs (150-170 N·m)
Rear Motor Mount Strut-to Engine Locknuts	155 ft-lbs (210 N·m)
Crankshaft Vibration Damper & Pulley Bolts	220 ft-lbs (298 N·m)
Oil Drain Plug	50 ft-lbs (67 N·m)
Alternator Mounting Bracket Bolts	35 ft-lbs (47 N·m)
Starter Mounting Bolts	160 ft-lbs (217 N·m)
Air Compressor Housing-to-Gear Case Bolts	75 ft-lbs (101 N·m)
Adapter and Steering Pump-to-Gear Case Bolts	75 ft-lbs (101 N·m)

SPECIFICATIONS

OIL FILTER ASSEMBLY

Part Number	1R0716 (Caterpillar)
Design	Spin-On Full-Flow
Location	(Filter Head Mounted) LH Side of Coach

FUEL FILTER ASSEMBLY (PRIMARY)

Part Number	1R0712 (Caterpillar)
Design	Spin-On
Location	(Filter Head Mounted) RH Side of Coach

WATER CHARGE FILTER ASSEMBLY

Part Number	1E6013 (Caterpillar)
Design	Spin-On
Location	(Filter Head Mounted) LH Side of Coach

SECTION 13

FULLER (T-11605) 5-SPEED MANUAL TRANSMISSION

Printed in U.S.A.

SECTION 13

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MANUAL TRANSMISSION (5-SPEED)

GENERAL DESCRIPTION

Some coaches may be equipped with the Fuller® Model T-11605-D or T-11605-F 5-speed manual transmission (Figure 1). These transmissions are designed with five forward speeds and one reverse. This series transmission is rated for engines up to 370 hp, and 1,150 ft-lbs torque (1559 N·m).

These transmissions feature heavy-duty cast steel housings, twin countershaft gear arrangements, fine pitch "multi-mesh" gearing, fork-actuated sliding clutch gear shifting, remote shift control, integral clutch housing release mechanism and reverse/neutral function and interlock switches.

Transmissions are shifted via a shift linkage connecting the lever-actuated master shift control to the transmission mounted remote slave shift control box. A standard three rail shift pattern is used for shifting function. Refer to "Shift Controls" for more information on the SCR-1 master shift control and LRC remote shift control boxes and the shift linkage.

The optional Model T-11605-F "fuel saver" manual transmission is often utilized in conjunction with drive axle installations having 3.33 or 3.85 gear ratios. This combination provides for greater fuel economy. Gear ratios on the T-11605-F differ from the T-11605-D.

COMPONENTS

COUNTERSHAFTS

Twin countershaft design divides the rated torque equally between two shafts. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of gears.

MAINSHAFT

The mainshaft assembly features the floating gear principle. These gears, when not engaged, "float" between the countershaft gears, eliminating the need for gear sleeves and bushings.

NOTE: Only the countershaft gears which mate with multi-mesh mainshaft gears have fine pitch gearing (i.e., first and reverse gears are of the coarse pitch conventional gearing type).

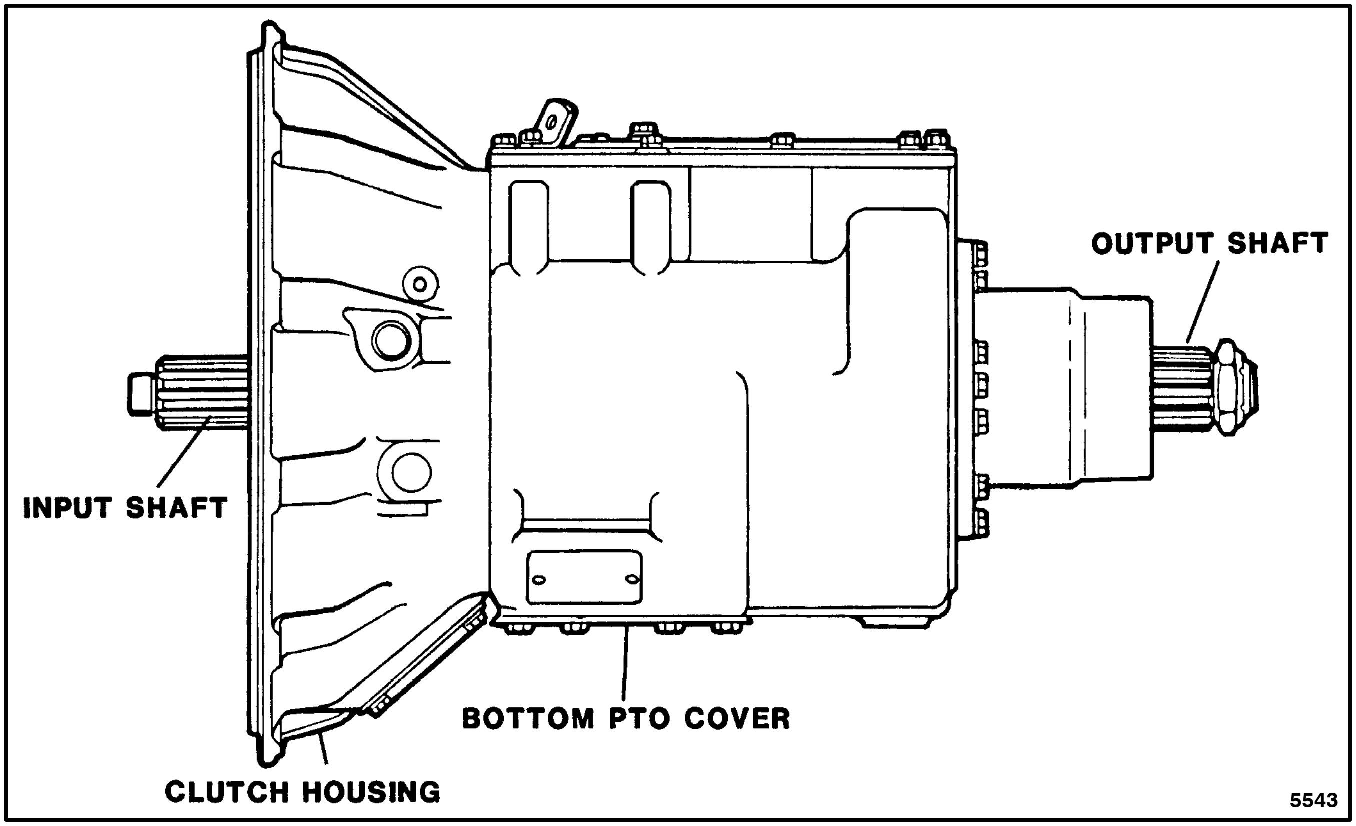

Figure 1. T-11605 Transmission

HOUSING

The clutch housing mounts to the engine, and the gear case and clutch housings bolt directly to each other. The gear case provides for oil sump, fill and drain plugs, remote shift control mounting and various bearing and inspection hand hole covers.

CLUTCH RELEASE MECHANISM

The clutch housing incorporates provisions for the pull-type clutch release bearing carrier, release yoke, shafts and adjustable actuating arm. The clutch control housing incorporates lube galleries for greasing the release bearing shafts. For more information regarding the release mechanism, see section 5.

SHIFT BAR HOUSING

The shift bar housing contains the shift forks that slide the clutch gears forward or backward to engage a specific gear. The LRC remote shift control is mounted to the top of the shift bar housing and actuates the shift forks.

DIPSTICK & FILL TUBE

A dipstick and filler tube are installed into the transmissions for easy filling and checking of transmission lubricant. Access to the dipstick and filler tube is through the LH rear side service door.

NOTE: Effective with unit 47701 the dipstick and filler tube will no longer be installed. The fill tube hole will be plugged.

OPERATION

To convert the constant high-speed, high-torque, rotational energy of the engine into a variable speed, higher torque low-inertia rotation that can be used to move the coach, the transmission must be able to be shifted from one gear range to another. Gear shifts are accomplished through an arrangement of three fork-actuated sliding clutch gears positioned along the mainshaft of the transmission.

Input shaft rotation is transmitted to twin countershafts either side of the mainshaft. The countershafts are fitted with gears that continuously rotate a mating gear on the mainshaft. Rotating mainshaft gears are not directly coupled to the mainshaft, therefore, shaft rotation is achieved only by engagement of the slide clutch gears.

Each sliding fork of the shift bar housing is attached to one of the sliding clutch gears. As a shift fork is indexed for a specific speed via the remote shift control, the clutch gear moves to engage the inner gear of the adjacent front or rear mainshaft floating gear. Engagement into the rotating mainshaft gear causes the slide gear to rotate and turn the mainshaft and output shaft. The selection and engagement of a specific gear thereby increases or decreases the output shaft speed of the transmission.

MAINTENANCE

PERIODIC INSPECTIONS

Every 5,000 miles (8,000 km) or 150 operating hours, clean the exterior of the transmission and make the following inspections:

1. Check all transmission-to-engine mounting fasteners.
2. Remove filler plug or dipstick and check lube oil level. Check for any oil leaks.
3. Check for correct adjustment and operation of the shift linkage and clutch release mechanism.

LUBRICATION

The transmission oil contained in the case splash lubricates all internal gears, bearings and shafts. Always maintain proper lube oil levels to assure a protective oil film on all loaded surfaces of gears and bearings. If fluid level is too low, metal-to-metal contact which causes scoring, scuffing and seizure could occur. If the level is too high, oil may be forced out of the case through the mainshaft openings.

Initial Service Interval

The initial “factory fill” lubricant should be drained between the first 3,000 to 5,000 miles (4,827 to 8,045 km).

CAUTION

During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles throughout the transmission and may cause excessive wear. Remove all metal particles found on the magnetic plug(s).

Periodic Service Interval

Every 50,000 miles (80,000 km) or 1,500 operating hours the transmission oil should be changed. Use lubrication specification S-13 (Mineral Gear Oil - MOBIL Mobilube C) or S-3 (Heavy Duty Engine Oil - MOBIL Super). In temperatures below 10 °F. use lubrication specification S-14 (Mineral Gear Oil - MOBIL Mobilube C) or S-4 (Heavy Duty Engine Oil - MOBIL Super) as shown in Section 10 of this manual.

1. Operate the transmission until normal operating temperature is reached.
2. Fill through dipstick tube to dipstick full level mark. On transmissions without dipstick, remove the side fill plug and refill the transmission until oil level is even with bottom of hole.
3. Thoroughly clean the plug(s) before re-installing.
4. Remove the bottom drain plug(s) and drain the oil while warm.

NOTE: Other lube oils may be substituted for the specifications listed above. Refer to the lubricant chart to determine the correct type and viscosity required. Different types or brands of oil should not be intermixed due to the possibility of oil component breakdown.

RECOMMENDED LUBRICANTS

Type	Grade (SAE)	Ambient Temperature
Heavy Duty Engine Oil MIL-L-2104C or MIL-L-46152 or API-SF or API-CD	50	Above 10°F (-12.2°C)
	40	Above 10°F (-12.2°C)
	30	Below 10°F (-12.2°C)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90	Above 10°F (-12.2°C)
	80W	Below 10°F (-12.2°C)
Mid EP Gear Oil* MIL-L-2105 or API-GL-4	90	10°F to 100° (-12.2°C to 38°C)
	80W	-15°F to 70°F (-26°C to 21°C)
Multipurpose Gear Oil* MIL-L-2105B or MIL-L-2105C or API-GL-5	85W144	Above 10°F (-12.2°C)
	80W140	Above -15°F (-26°C)
	90	10°F to 100°F (-12.2°C to 38°C)
	80W90	-15°F to 100°C (-26°C to 38°C)
	80W	15°F to 70° (-9.4°C to 21°C)
	75W	-40°F to 15°F (-40°C to 26°C)

*Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).

Lubricant Chart

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 11 of the removal procedure. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.
2. Drain the lubricant from the transmission, and remove the dipstick and tube if equipped.
3. Disconnect the reverse switch harness and tone ring speed sensor harness if equipped.
4. Loosen turnbuckle and unfasten the clutch release arm return springs.
5. Disconnect the clutch rear control cable from release arm.

6. Rotate the lever to permit the release yoke fork to turn up and pull free of the clutch release bearing.

7. Unfasten and remove the splined lever and slide release arm off shaft.

8. Disconnect the driveshaft from the transmission. Refer to the “Driveshaft Removal” procedure in section 14.

9. Disconnect the shift linkage from the LRC remote shift control box. Refer to the “Shift Linkage Removal” procedure in section 13D.

NOTE: Unfasten the selector rod from the shift lever and pivot link rod by removing cotter keys and nuts. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage. This will result in maladjustment of the linkage.

10. Remove the engine and transmission module as an assembly. Refer to the “Engine Removal” procedure shown in section 8A1 thru 8A4.

11. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ **CAUTION** ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent clutch and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

NOTE: Inspect the engine-to-transmission mounting surfaces, pilot shaft bearing and bearing mount in flywheel for any signs of wear.

INSTALLATION

1. Install the transmission in reverse order of the “Removal” procedure. Refer to the “Yoke to Bearing Installation” procedure in section 5, and the “Shift Linkage Installation” procedure in section 13D when reinstalling the transmission.

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IT THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.

TORQUE SPECIFICATIONS

Main Drive Gear Bearing Nut	250-300 ft-lbs
Mainshaft Rear Bearing Cover Capscrews	35-45 ft-lbs
Clutch Housing Capscrews	90-100 ft-lbs
Clutch Housing Hand Hole Cover Capscrews	20-25 ft-lbs
Front Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Rear Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Oil Drain Plug	45-55 ft-lbs
Oil Fill Plug	60-75 ft-lbs
Output Shaft Yoke Nut	400-450 ft-lbs
Shift Bar Housing Capscrews	35-45 ft-lbs
LRC Remote Shift Control Housing Capscrews	35-45 ft-lbs
Reverse & Neutral Signal Switches	35-45 ft-lbs

SPECIFICATIONS

TRANSMISSION ASSEMBLY

Manufacturer	Eaton/Fuller
Part Number (Model T-11605-D)	13L-1-80
Part Number (Model T-11605-D W/Tone Ring)	13L-1-151
Part Number (Model T-11605-F)	13L-1-81
Part Number (Model T-11605-F W/Tone Ring)	13L-1-153

TRANSMISSION GEAR RATIOS

First Gear (Model T-11605-D)	5.46
First Gear (Model T-11605-F)	7.20
Second Gear (Model T-11605-D)	3.23
Second Gear (Model T-11605-F)	3.90
Third Gear (Model T-11605-D)	2.05
Third Gear (Model T-11605-F)	2.12
Fourth Gear (Model T-11605-D)	1.31
Fourth Gear (Model T-11605-F)	1.46
Fifth Gear (Model T-11605-D)	1.00
Fifth Gear (Model T-11605-F)	1.00
Reverse Gear (Model T-11605-D)	5.57
Reverse Gear (Model T-11605-F)	7.09

CAPACITY SCHEDULE

T-11605-D	Initial Factory Fill: 22 Pts. (10 L)	Service Fill: 22 Pts. (10 L)
T-11605-F	Initial Factory Fill: 22 Pts. (10 L)	Service Fill: 22 Pts. (10 L)

SHIFT CONTROLS

GENERAL DESCRIPTION

Coaches equipped with the Eaton/Fuller T-11605 manual transmission installations will feature a mechanically actuated remote shifting arrangement. The driver operated shift lever connects to a master shift control box, which is interconnected via shift linkage to the transmission mounted remote shift control box. Each sliding fork of the transmission shift bar housing may be indexed for a specific shift via the remote shift control. The remote control box mimics the master control box shift lever selections to shift the transmission into a desired gear or range of gears.

COMPONENTS

SHIFT LEVER

The floor mounted shift lever is located to the right of the driver. The lever is connected to the SCR master shift control box. A standard three-rail shift pattern is shown for the 5-speed (Figure 1).

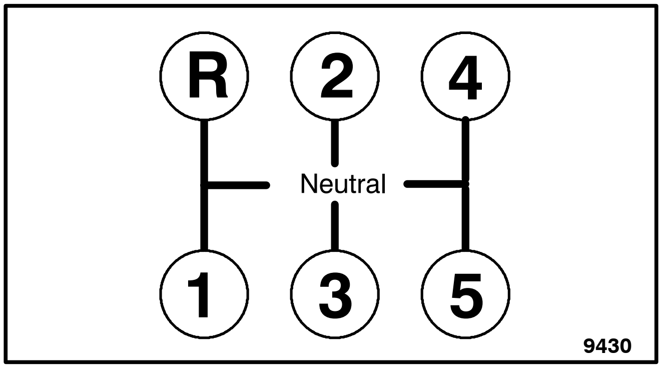

Figure 1. 5-Speed Shift Pattern

MASTER SHIFT CONTROL

The SRC master control box is located beneath the floor mounted shift lever. The master control transmits the movements of the shift lever to the shift linkage.

SHIFT LINKAGE

The shift linkage runs the length of the coach within the center tunnel. The linkage transmits the movements of the shift lever to the selector lever of the remote shift control box. A turnbuckle adjustment is incorporated at the rear of the linkage for positive shifting.

REMOTE SHIFT CONTROL

The LRC remote shift control is mounted to the top of the shift bar housing. The shift linkage is attached to a threaded selector lever, which in turn is connected to the inner shift shaft of the remote control box via a shift lever. The selector lever is also connected to a stationary pivot link assembly that keeps the selector lever in proper alignment (Figure 2). The inner shift shaft is fitted with the inner shift finger that controls shift fork function.

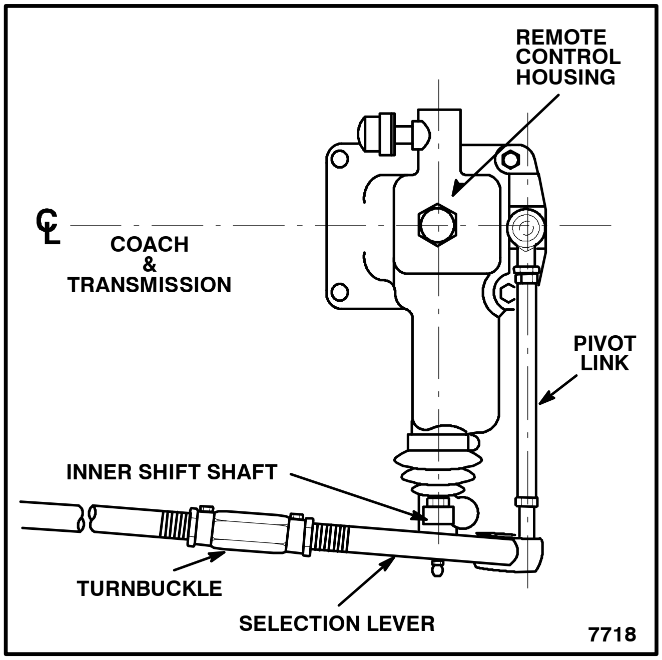

Figure 2. Remote Box Shift Linkage

MAINTENANCE

LUBRICATION

Lubrication of the entire shift linkage is recommended at 75,000 miles (121,000 km) or 2,250 operating hours. Lubricate the master and slave shift control boxes, carrier bearings, U-joints and all ball joints of the linkage through the grease fittings provided. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL-MOBILITH AW-1).

NOTE: Front U-joints and bearings lube fittings are accessed through the front bogie fitting and tire compartment, while the rear U-joint and bearings are accessed at the rear bogie cover.

ADJUSTMENT

Proper adjustment of the LRC remote control shift linkage is necessary for smooth shift operations. When adjusting the shift linkage, follow the procedures outlined below in order to insure that the linkage is set properly for smooth and trouble-free operation.

Slave Control Linkage

1. Place battery disconnect switch “Off”. Apply the parking brake.

2. Move the gear shift lever forward or backward to place inner shift finger in the neutral position.

3. Move the the gear shift lever sideways, towards reverse, until resistance from the reverse plunger spring is felt. Do not overcome this spring tension, and leave the inner shift shaft shift finger in this position while making adjustments.

4. Unfasten and remove the pivot link cotter pin, castle nut and ball joint from the selection lever (Figure 3). Do not remove the ball joint from the pivot link.

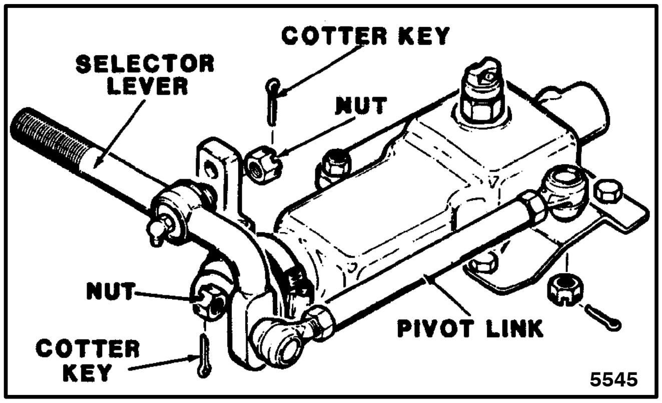

Figure 3. Disconnecting Shift Linkage

5. Unfasten and remove the capscrew retaining the shift arm to the inner shift shaft. Do not disconnect the selection lever from the shift arm (Figure 4).

6. Turn the shift arm until it is at a right angle (90 degree) to the selection lever as viewed from the side (Figure 5).

NOTE: Ideally, the shift arm should be adjusted 90° to the selection lever as described, but in some chassis configurations it may be necessary to index the shift arm in the vertical position. This is done to prevent a “shift lever jump out condition”. This type adjustment will cause an unequal amount of gear shift lever travel between neutral and a forward lever position as compared to a neutral to rearward lever position.

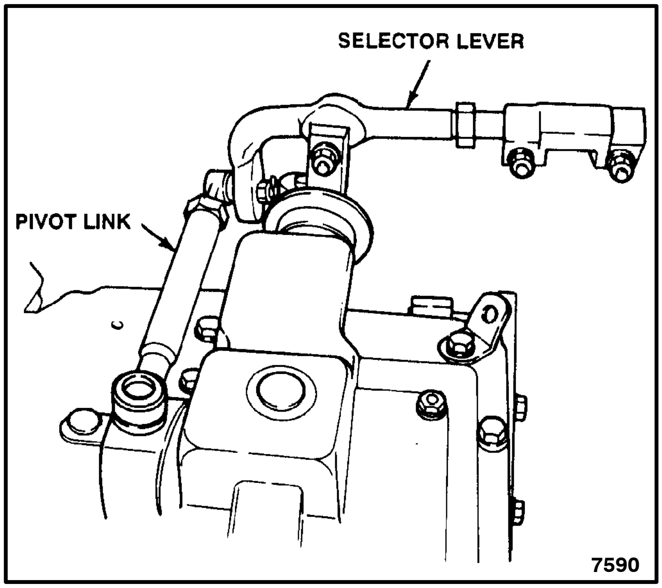

Figure 4. Selector Lever to Shift Arm

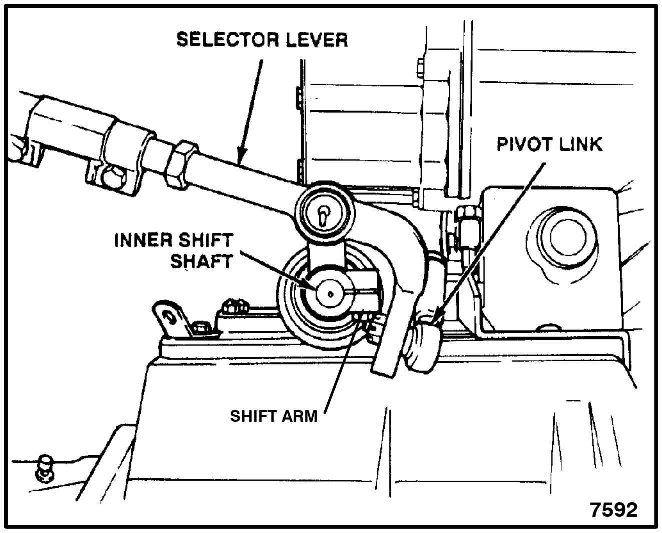

Figure 5. Linkage Components

7. Reinstall the shift arm on the splines of the inner shift shaft and tighten. The shift arm may have to be moved 4 or 5 degrees to align the splines of the two parts.

8. Reconnect pivot link assembly ball joint to selection lever and secure.

9. Loosen the jam nuts on both ends of the pivot link, and rotate pivot link until curved end of selection lever is parallel with the shift arm as viewed from the rear (Figure 6).

NOTE: Inner shift finger must still be positioned as described in steps 1 and 2.

Shift Lever (Neutral)

1. Loosen both capscrews on the turnbuckle linear adjustment at rear linkage reach rod to selection lever (Figure 7).

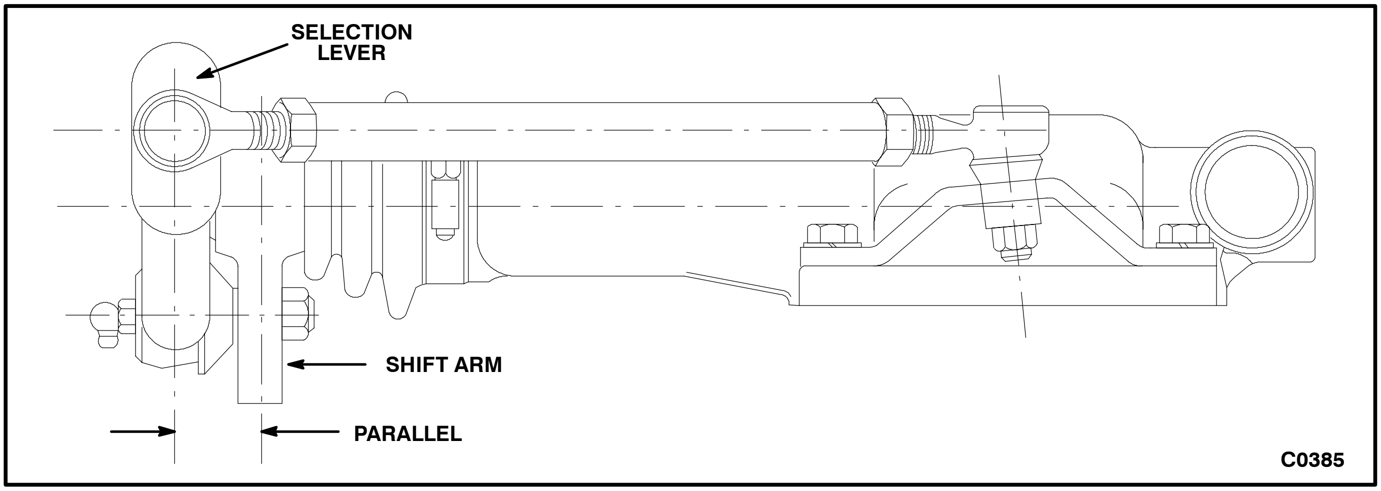

Figure 6. Pivot Link Alignment

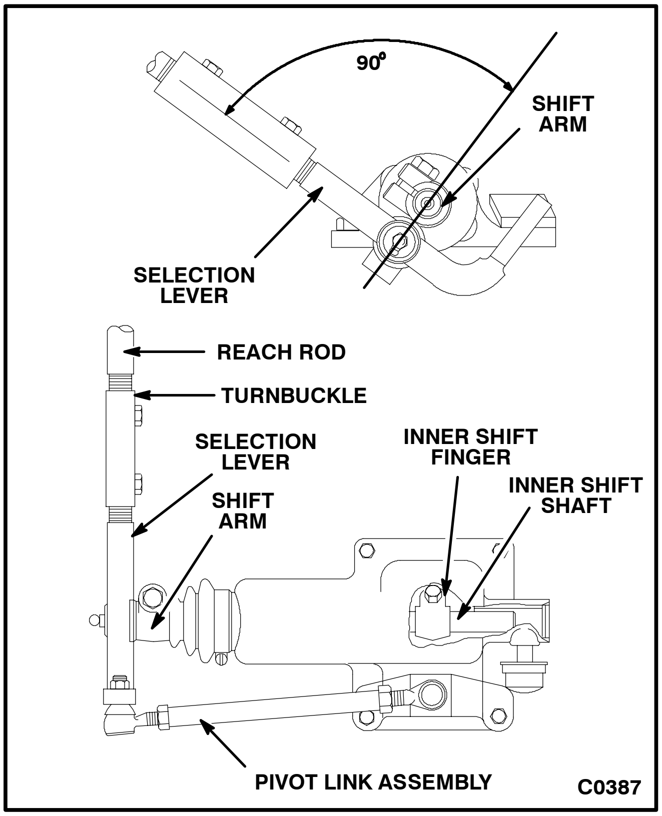

Figure 7. Components

NOTE: Again, check that inner shift finger is still positioned as described in steps 1 and 2 of the previous adjustment procedure.

2. Rotate turnbuckle to obtain the proper forward or rearward (neutral) position of the gear shift lever.

3. Tighten one of the turnbuckle clamp capscrews to secure this adjustment.

4. Move the gear shift lever to the desired left-right (neutral) position, and tighten the second turnbuckle clamp capscrew.

5. Check for any linkage interference, binding or obstruction in all gears shift positions.

REMOVAL

Rear Linkage

1. Unfasten the rear selector lever from the shift arm and pivot link rod by removing cotter keys and nuts.

2. Loosen both capscrews on the turnbuckle at rear shift linkage and turn off rear shift control rod to remove.

NOTE: Do not disconnect the linkage from the turnbuckle which connects the selector lever to the linkage rear shift rod. This will result in maladjustment of the linkage at reinstallation.

3. Unfasten and remove the pivot link from the transmission mount bracket.

4. Unfasten and remove the shift arm from the inner shift shaft splines.

5. Remove the rear bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

6. Unfasten and remove the rear U-joint and shift rod assembly at its connection with the center tunnel shift tube.

7. Unfasten and remove the flange mounted rear shift tube carrier bearing.

Front Linkage

1. Unfasten the shift lever boot and cover drivers floor and pull shift lever from master shift control box.

NOTE: Shift levers with air control buttons must have master control knob disassembled and removed from shift lever.

2. Unfasten and remove the front U-joint and master shift control box at its connection with the front of first shift rod.

NOTE: Further access for disassembly and removal of the shift linkage requires that the center aisle ramp or the front bogie closing panel and the #1 baggage bay center tunnel closing panels be removed.

3. Unfasten and remove the front tire compartment rear panel plate and boot assembly.

4. Remove either the ramp or front bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

5. Unfasten and remove the U-joint and first shift rod assembly at its connection with the second (ramp) shift rod.

6. Unfasten and remove the flange mounted front shift rod carrier bearing from the front of the second shift rod.

7. Remove the center tunnel cover panel, and disconnect the rest of the U-joint and carrier bearing lube lines.

8. Unfasten and remove the U-joint and second shift rod assembly at its connection with the center tunnel shift tube.

9. Unfasten and remove the flange mounted intermediate shift rod carrier bearing from the front of the shift tube assembly.

NOTE: Shift tube may be removed in pieces by cutting.

INSTALLATION

1. Reassemble and install in reverse order of “Removal” procedure and readjust the linkage.

SPECIFICATIONS

SRC MASTER SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number	13G-7-121

LRC SLAVE SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number (5-Speed T-11605-D)	13J-2-52
Part Number (5-Speed T-11605-F)	13J-2-56

MAINTENANCE MANUAL

Date September 1997

SECTION 13

FULLER (T-14607) 7-SPEED MANUAL TRANSMISSION

P/N 3L-15-1457B . . . . SEPTEMBER 1997

MOTOR COACH INDUSTRIES

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SECTION 13

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MANUAL TRANSMISSION (7-SPEED)

GENERAL DESCRIPTION

Some coaches may be equipped with the Fuller® Model T-14607-A or TX-14607-B 7-speed manual transmission (Figure 1). These transmissions are designed with seven forward speeds and one reverse. This series transmission is rated for engines up to 400 hp, and 1,400 ft-lbs torque (1897 N·m).

These transmissions feature heavy-duty cast steel housings, twin countershaft gear arrangements, fine pitch “multi-mesh” gearing, two-piece input shaft and drive gear design, remote shift control and integral clutch housing release mechanism.

Transmissions are shifted via a shift linkage connecting the lever actuated master shift control to the transmission-mounted remote slave shift control box. A standard four-rail shift pattern is used for shifting function. Refer to “Shift Controls” for more information on the SCR master shift control and LRC remote shift control boxes and the shift linkage.

The optional Model TX-14607-B “fuel saver” manual transmission may be utilized in conjunction with drive axle installations having 3.33 or 3.85 gear ratios. This combination provides for greater fuel economy. Gear ratios on the TX-14607-B differ from the T-14607-A.

COMPONENTS

COUNTERSHAFTS

Twin countershaft design divides the rated torque equally between two shafts. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of gears.

MAINSHAFT

The mainshaft assembly features the floating gear principle. These gears, when not engaged by the slide clutch gears, “float” on or between their adjacent twin countershaft gears, eliminating the need for gear sleeves and bushings.

NOTE: Only the countershaft gears which mate with multi-mesh mainshaft gears have fine pitch gearing (i.e., first and reverse gears are of the coarse pitch conventional gearing type).

CLUTCH RELEASE MECHANISM

The clutch housing incorporates provisions for the pull-type clutch release bearing carrier, release yoke, shafts and adjustable actuating arm. The clutch control housing incorporates lube galleries for greasing the release bearing shafts. For more information regarding the release mechanism, see section 5.

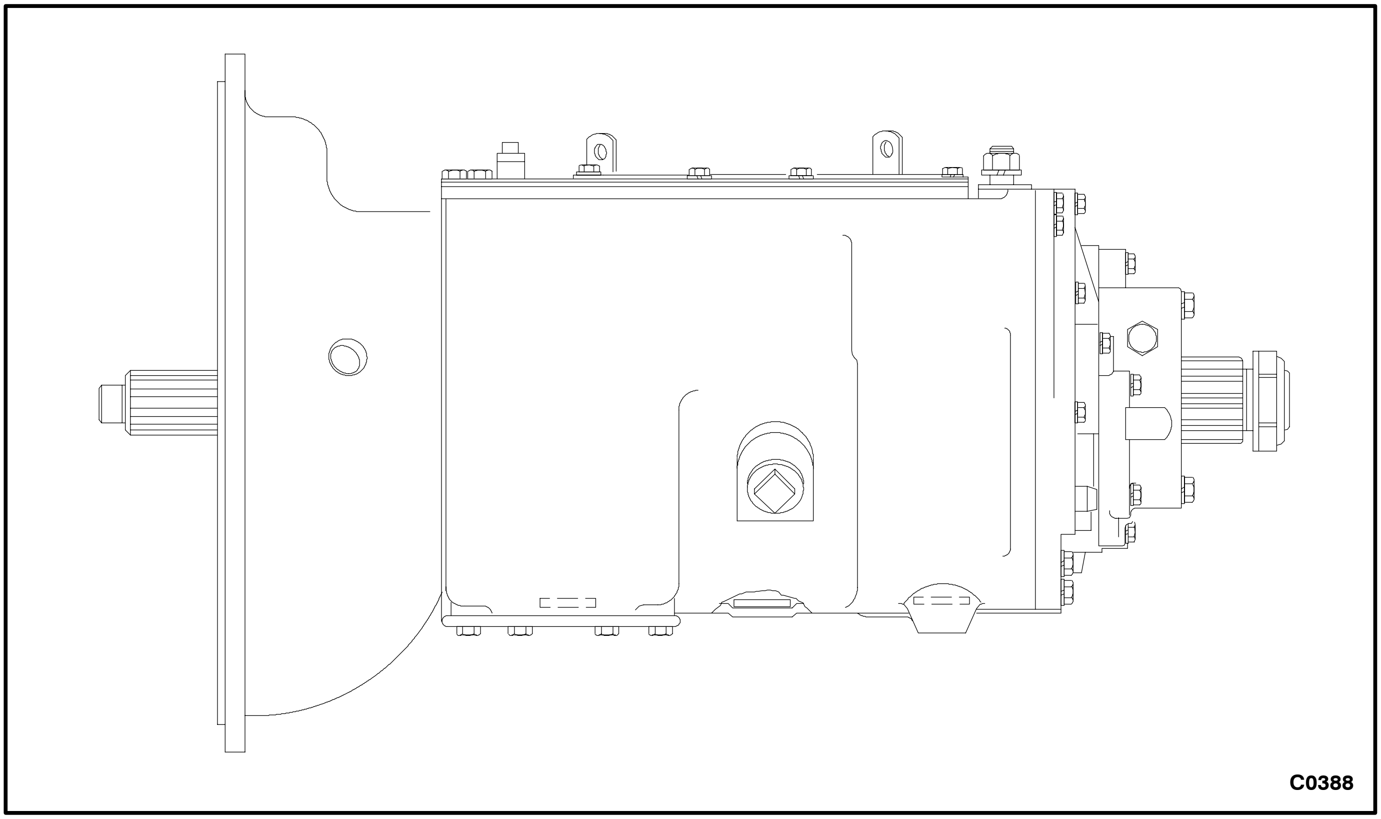

Figure 1. T-14607 Transmission

HOUSING

The clutch housing mounts to the engine, and the gear case and clutch housings bolt directly to each other. The gear case provides for oil sump, fill and drain plugs, remote shift control mounting and various bearing and inspection hand hole covers.

SHIFT BAR HOUSING

The shift bar housing contains the shift forks that slide the clutch gears forward or backward to engage a specific gear. The LRC remote shift control is mounted to the top of the shift bar housing and actuates the shift forks.

NOTE: There is a longer throw in the 6th and 7th shift patterns, which indicates the increased engagement contact of the sliding clutch gear teeth.

DIPSTICK & FILL TUBE

A dipstick and filler tube are installed into the transmissions for easy filling and checking of transmission lubricant. Access to the dipstick and filler tube is through the LH rear side service door.

NOTE: Effective with unit 47701 the dipstick and filler tube will no longer be installed. The fill tube hole will be plugged.

OPERATION

To convert the constant high-speed, high-torque, rotational energy of the engine into a variable speed, higher torque low-inertia rotation that can be used to move the coach, the transmission must be able to be shifted from one gear range to another. Gear shifts are accomplished through an arrangement of four fork-actuated sliding clutch gears positioned along the mainshaft of the transmission.

Input shaft rotation is transmitted to twin countershafts either side of the mainshaft. The countershafts are fitted with gears that continuously rotate a mating gear on the mainshaft. Rotating mainshaft gears are not directly coupled to the mainshaft, therefore, shaft rotation is achieved only by engagement of the slide clutch gears.

Each sliding fork of the shift bar housing is attached to one of the sliding clutch gears. As a shift fork is indexed for a specific speed via the remote shift control, the clutch gear moves to engage the inner gear of the adjacent front or rear mainshaft floating gear. Engagement into the rotating mainshaft gear causes the slide gear to rotate and turn the mainshaft and output shaft. The selection and engagement of a specific gear thereby increases or decreases the output shaft speed of the transmission.

MAINTENANCE

PERIODIC INSPECTIONS

Every 5,000 miles (8,000 km) or 150 operating hours, clean the exterior of the transmission and make the following inspections:

1. Check all transmission to engine mounting fasteners.

2. Remove filler plug or dipstick and check lube oil level. Check for any oil leaks.

3. Check for correct adjustment and operation of the shift linkage and clutch release mechanism.

LUBRICATION

The transmission oil contained in the case splash lubricates all internal gears, bearings and shafts. Always maintain proper lube oil levels to assure a protective oil film on all loaded surfaces of gears and bearings. If fluid level is too low, metal-to-metal contact which causes scoring, scuffing and seizure could occur. If the level is too high, oil may be forced out of the case through the mainshaft openings.

Initial Service Interval

The initial “factory fill” lubricant should be drained between the first 3,000 to 5,000 miles (4,827 to 8,045 km).

CAUTION

During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles throughout the transmission and may cause excessive wear. Remove all metal particles found on the magnetic plug(s).

Every 50,000 miles (80,000 km) or 1,500 operating hours, the transmission oil should be changed. Use lubrication specification S-13 (Mineral Gear Oil - MOBIL Mobilube C) or S-3 (Heavy Duty Engine Oil - MOBIL Super). In temperatures below 10 °F. use lubrication specification S-14 (Mineral Gear Oil - MOBIL Mobilube C) or S-4 (Heavy Duty Engine Oil - MOBIL Super) as shown in Section 10 of this manual.

1. Operate the transmission until normal operating temperature is reached.

2. Remove the bottom drain plug(s) and drain the oil while warm.

3. Fill through dipstick tube to dipstick full level mark. On transmissions without dipstick, remove the side fill plug and refill the transmission until oil level is even with bottom of hole.

4. Thoroughly clean the plug(s) before re-installing.

NOTE: Other lube oils may be substituted for the specifications listed above. Refer to the lubricant chart to determine the correct type and viscosity required. Different types or brands of oil should not be intermixed due to the possibility of oil component breakdown.

RECOMMENDED LUBRICANTS

Type	Grade (SAE)	Ambient Temperature
Heavy Duty Engine Oil MIL-L-2104C or MIL-L-46152 or API-SF or API-CD	50 40 30	Above 10°F (-12.2°C) Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90 80W	Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mid EP Gear Oil* MIL-L-2105 or API-GL-4	90 80W	10°F to 100° (-12.2°C to 38°C) -15°F to 70°F (-26°C to 21°C)
Multipurpose Gear Oil* MIL-L-2105B or MIL-L-2105C or API-GL-5	85W144 80W140 90 80W90 80W 75W	Above 10°F (-12.2°C) Above -15°F (-26°C) 10°F to 100°F (-12.2°C to 38°C) -15°F to 100°C (-26°C to 38°C) 15°F to 70° (-9.4°C to 21°C) -40°F to 15°F (-40°C to 26°C)

*Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).

Lubricant Chart

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 11 of the removal procedure. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Drain the lubricant from the transmission, and remove the dipstick and tube if equipped.

3. Disconnect the reverse switch harness and tone ring speed sensor harness if equipped.

4. Loosen turnbuckle and unfasten the clutch release arm return springs.

5. Disconnect the clutch rear control cable from release arm.

6. Rotate the lever to permit the release yoke fork to turn up and pull free of the clutch release bearing.

7. Unfasten and remove the splined lever and slide release arm off shaft.

8. Disconnect the driveshaft from the transmission. Refer to the "Driveshaft Removal" procedure in section 14.

9. Disconnect the shift linkage from the LRC remote shift control box. Refer to the "Shift Linkage Removal" procedure in section 13D.

NOTE: Unfasten the selector rod from the shift lever and pivot link rod by removing cotter keys and nuts. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage. This will result in maladjustment of the linkage.

10. Remove the engine and transmission module as an assembly. Refer to the "Engine Removal" procedure shown in section 8A1 thru 8A4.

11. Disconnect the transmission bottom support mounting fasteners from the engine cradle if equipped.

12. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ **CAUTION** ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent clutch and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

NOTE: Inspect the engine-to-transmission mounting surfaces, pilot shaft bearing and bearing mount in flywheel for any signs of wear.

INSTALLATION

1. Install the transmission in reverse order of the "Removal" procedure. Refer to the "Yoke to Bearing Installation" procedure in section 5, and the "Shift Linkage Installation" procedure in section 13D when reinstalling the transmission.

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IT THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.

TORQUE SPECIFICATIONS

Main Drive Gear Bearing Nut	250-300 ft-lbs
Mainshaft Rear Bearing Cover Capscrews	35-45 ft-lbs
Clutch Housing Capscrews	90-100 ft-lbs
Clutch Housing Hand Hole Cover Capscrews	20-25 ft-lbs
Front Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Rear Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Oil Drain Plug	45-55 ft-lbs
Oil Fill Plug	60-75 ft-lbs
Output Shaft Yoke Nut	400-450 ft-lbs
Shift Bar Housing Capscrews	35-45 ft-lbs
LRC Remote Shift Control Housing Capscrews	35-45 ft-lbs
Reverse Signal Switch	35-45 ft-lbs

SPECIFICATIONS

TRANSMISSION ASSEMBLY

Manufacturer	Eaton/Fuller
Part Number (Model T-14607-A)	13L-1-82
Part Number (Model T-14607-A W/Tone Ring)	13L-1-155
Part Number (Model TX-14607-B)	13L-1-118
Part Number (Model TX-14607-B W/Tone Ring)	13L-1-157

TRANSMISSION GEAR RATIOS

First Gear (Model T-14607-A)	10.50
First Gear (Model TX-14607-B)	9.24
Second Gear (Model T-14607-A)	6.13
Second Gear (Model TX-14607-B)	5.35
Third Gear (Model T-14607-A)	3.71
Third Gear (Model TX-14607-B)	3.22
Fourth Gear (Model T-14607-A)	2.51
Fourth Gear (Model TX-14607-B)	2.04
Fifth Gear (Model T-14607-A)	1.83
Fifth Gear (Model TX-14607-B)	1.37
Sixth Gear (Model T-14607-A)	1.34
Sixth Gear (Model TX-14607-B)	1.00
Seventh Gear (Model T-14607-A)	1.00
Seventh Gear (Model TX-14607-B)	.75
Reverse Gear (Model T-14607-A)	10.20
Reverse Gear (Model TX-14607-B)	8.99

CAPACITY SCHEDULE

T-14607-A	Initial Factory Fill: 36 Pts. (17.5 L)	Service Fill: 36 Pts. (17.5 L)
TX-14607-B	Initial Factory Fill: 36 Pts. (17.5 L)	Service Fill: 36 Pts. (17.5 L)

SHIFT CONTROLS

GENERAL DESCRIPTION

Coaches equipped with the Eaton/Fuller T-11607 7-Speed manual transmission installations will feature a mechanically actuated remote shifting arrangement. The driver operated shift lever connects to a master shift control box, which is interconnected via shift linkage to the transmission-mounted remote shift control box. Each sliding fork of the transmission shift bar housing may be indexed for a specific shift via the remote shift control. The remote control box mimics the master control box shift lever selections to shift the transmission into a desired gear or range of gears.

COMPONENTS

SHIFT LEVER

The floor-mounted shift lever is located to the right of the driver. The lever is connected to the SCR master shift control box. A standard four-rail shift pattern is shown for the 7-speed transmissions (Figure 2).

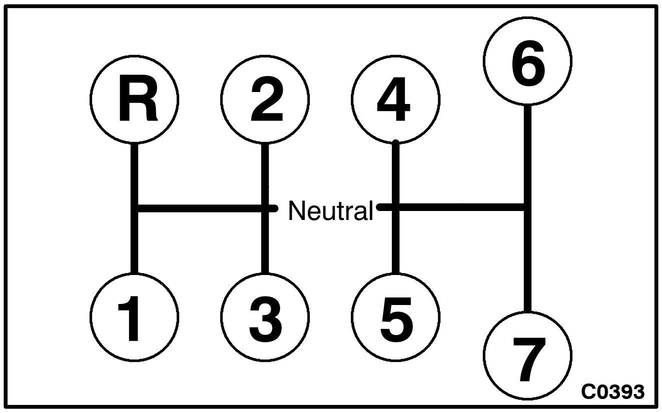

Figure 2. 7-Speed Shift Pattern

MASTER SHIFT CONTROL

The SRC master control box is located beneath the floor-mounted shift lever. The master control transmits the movements of the shift lever to the shift linkage.

SHIFT LINKAGE

The shift linkage runs the length of the coach within the center tunnel. The linkage transmits the movements of the shift lever to the selector lever of the remote shift control box. A turnbuckle adjustment is incorporated at the rear of the linkage for positive shifting.

REMOTE SHIFT CONTROL

The LRC remote shift control is mounted to the top of the shift bar housing. The shift linkage is attached to a threaded selector lever, which in turn is connected to the inner shift shaft of the remote control box via a shift lever. The selector lever is also connected to a stationary pivot link assembly that keeps selector lever in proper alignment (Figure 3). The inner shift shaft is fitted with the inner shift finger that controls shift fork function.

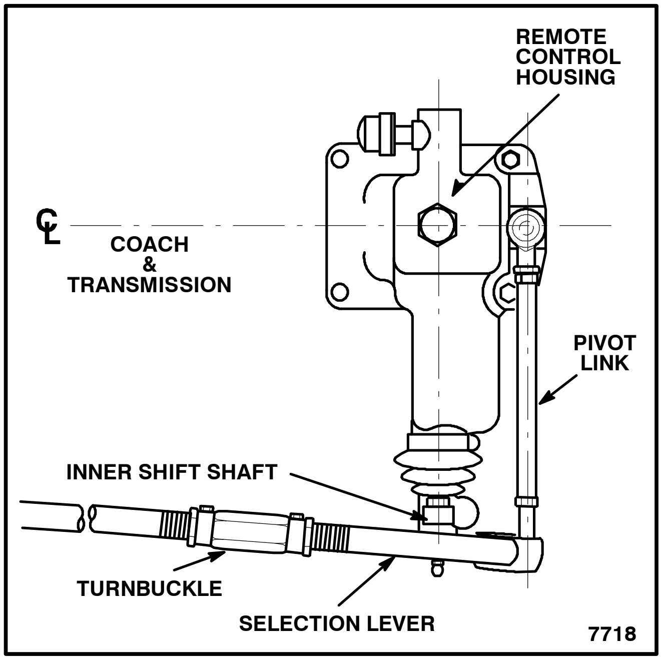

Figure 3. Remote Box Shift Linkage

MAINTENANCE

LUBRICATION

Lubrication of the entire shift linkage is recommended at 75,000 miles (121,000 km) or 2,250 operating hours. Lubricate the master and slave shift control boxes, carrier bearings, U-joints and all ball joints of the linkage through the grease fittings provided. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL-MOBILITH AW-1).

NOTE: Front U-joints and bearings lube fittings are accessed through the front bogie fitting and tire compartment, while the rear U-joint and bearings are accessed at the rear bogie cover.

ADJUSTMENT

Proper adjustment of the LRC remote control shift linkage is necessary for smooth shift operations. When adjusting the shift linkage, follow the procedures outlined below in order to insure that the linkage is set properly for smooth and trouble-free operation.

Slave Control Linkage

1. Place battery disconnect switch “Off”. Apply the parking brake.

2. Move the gear shift lever forward or backward to place inner shift finger in the neutral position.

3. Move the the gear shift lever sideways, towards reverse, until resistance from the reverse plunger spring is felt. Do not overcome this spring tension, and leave the inner shift finger in this position while making adjustments.

4. Unfasten and remove the pivot link cotter pin, castle nut and ball joint from the selection lever (Figure 4). Do not remove the ball joint from the pivot link.

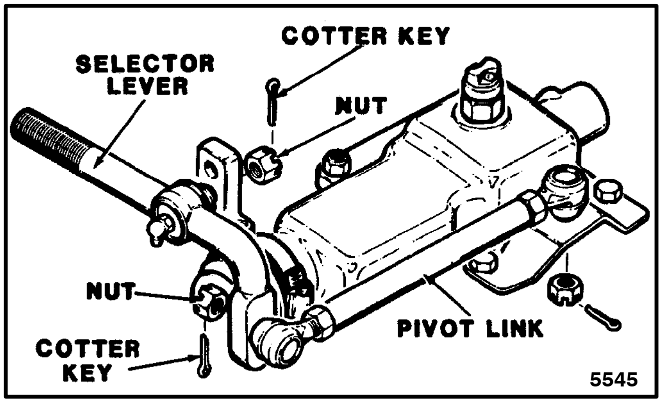

Figure 4. Disconnecting Shift Linkage

5. Unfasten and remove the capscrew retaining the shift arm to the inner shift shaft. Do not disconnect the selection lever from the shift arm (Figure 5).

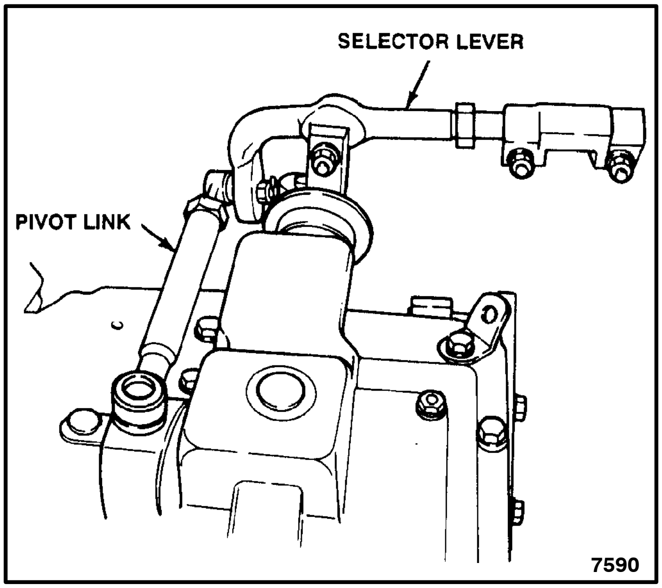

Figure 5. Selector Lever to Shift Arm

6. Turn the shift arm until it is at a right angle (90 degree) to the selection lever as viewed from the side (Figure 6).

NOTE: Ideally, the shift arm should be adjusted 90° to the selection lever as described, but in some chassis configurations it may be necessary to index the shift arm in the vertical position. This is done to prevent a “shift lever jump out condition”. This type adjustment will cause an unequal amount of gear shift lever travel between neutral and a forward lever position as compared to a neutral to rearward lever position.

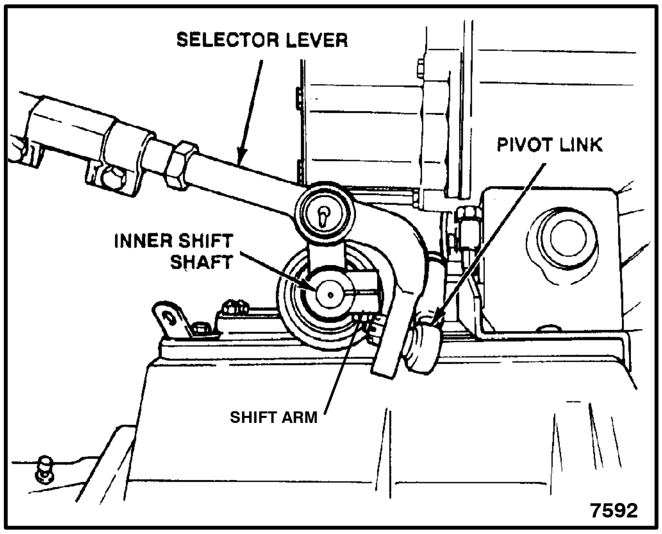

Figure 6. Linkage Components

7. Reinstall the shift arm on the splines of the inner shift shaft and tighten. The shift arm may have to be moved 4 or 5 degrees to align the splines of the two parts.

8. Reconnect pivot link assembly ball joint to selection lever and secure.

9. Loosen the jam nuts on both ends of the pivot link, and rotate pivot link until curved end of selection lever is parallel with the shift arm as viewed from the rear (Figure 7).

NOTE: Inner shift finger must still be positioned as described in steps 1 and 2.

Shift Lever (Neutral)

1. Loosen both capscrews on the turnbuckle linear adjustment at rear linkage reach rod to selection lever (Figure 8).

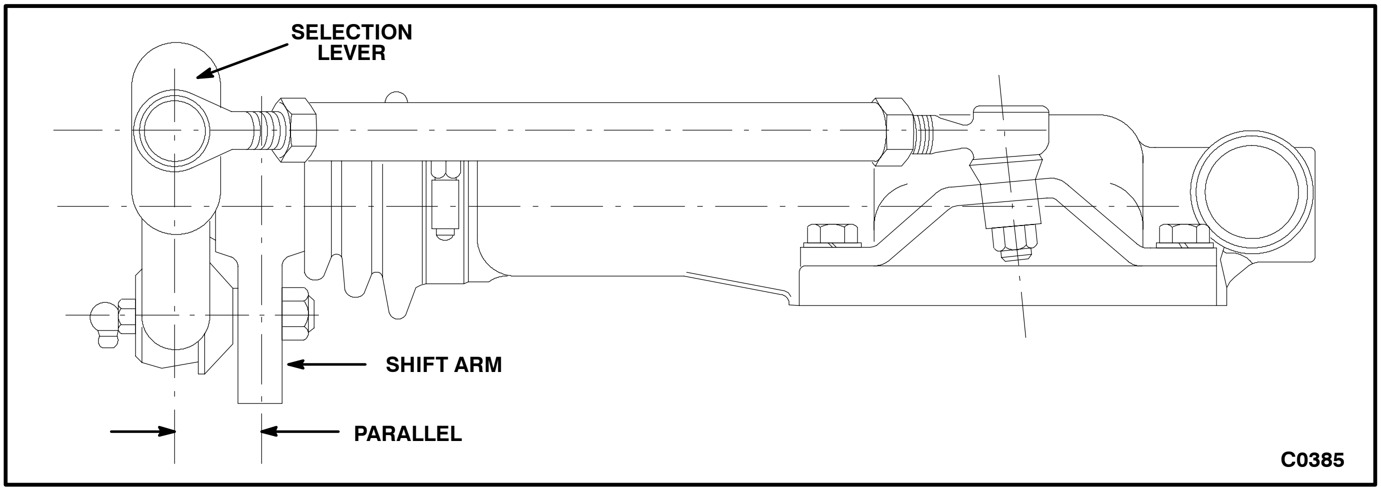

Figure 7. Pivot Link Alignment

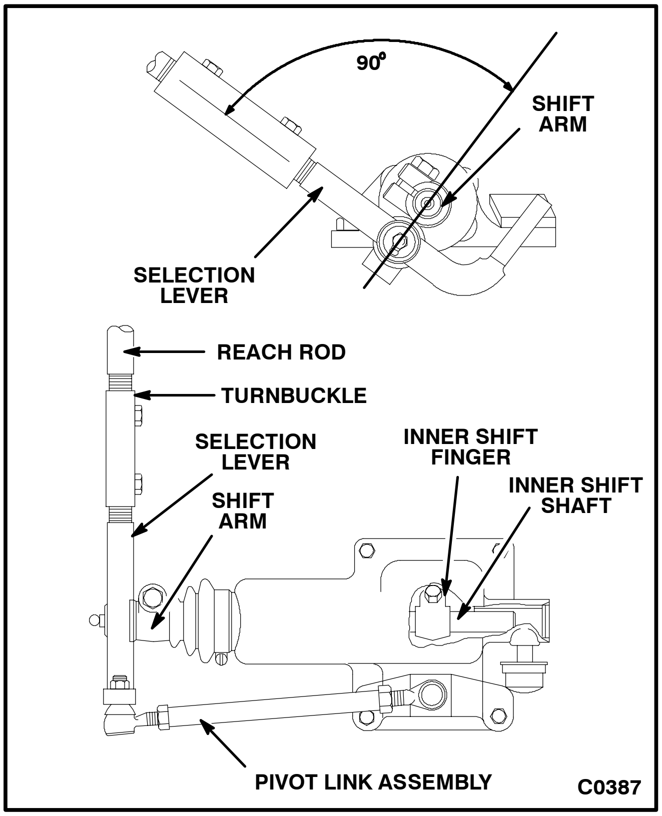

Figure 8. Components

NOTE: Again, check that inner shift finger is still positioned as described in steps 1 and 2 of the previous adjustment procedure.

2. Rotate turnbuckle to obtain the proper forward or rearward (neutral) position of the gear shift lever.

3. Tighten one of the turnbuckle clamp capscrews to secure this adjustment.

4. Move the gear shift lever to the desired left-right (neutral) position, and tighten the second turnbuckle clamp capscrew.

5. Check for any linkage interference, binding or obstruction in all gear shift positions.

REMOVAL

Rear Linkage

1. Unfasten the rear selector lever from the shift arm and pivot link rod by removing cotter keys and nuts.

2. Loosen both capscrews on the turnbuckle at rear shift linkage and turn off rear shift control rod to remove.

NOTE: Do not disconnect the linkage from the turnbuckle which connects the selector lever to the linkage rear shift rod. This will result in maladjustment of the linkage at reinstallation.

3. Unfasten and remove the pivot link from the transmission mount bracket.

4. Unfasten and remove the shift arm from the inner shift shaft splines.

5. Remove the rear bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

6. Unfasten and remove the rear U-joint and shift rod assembly at its connection with the center tunnel shift tube.

7. Unfasten and remove the flange-mounted rear shift tube carrier bearing.

Front Linkage

1. Unfasten the shift lever boot and cover on driver's floor and pull shift lever from master shift control box.

NOTE: Shift levers with air control buttons must have master control knob disassembled and removed from shift lever.

2. Unfasten and remove the front U-joint and master shift control box at its connection with the front of first shift rod.

NOTE: Further access for disassembly and removal of the shift linkage requires that the center aisle ramp or the front bogie closing panel and the #1 baggage bay center tunnel closing panels be removed.

3. Unfasten and remove the front tire compartment rear panel plate and boot assembly.

4. Remove either the ramp or front bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

5. Unfasten and remove the U-joint and first shift rod assembly at its connection with the second (ramp) shift rod.

6. Unfasten and remove the flange-mounted front shift rod carrier bearing from the front of the second shift rod.

7. Remove the center tunnel cover panel, and disconnect the rest of the U-joint and carrier bearing lube lines.

8. Unfasten and remove the U-joint and second shift rod assembly at its connection with the center tunnel shift tube.

9. Unfasten and remove the flange-mounted intermediate shift rod carrier bearing from the front of the shift tube assembly.

NOTE: Shift tube may be removed in pieces by cutting.

INSTALLATION

1. Reassemble and install in reverse order of “Removal” procedure and readjust the linkage.

SPECIFICATIONS

SRC MASTER SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number	13L-7-170

LRC SLAVE SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number (7-Speed Without Tone Ring T-14607-A)	13L-2-279
Part Number (7-Speed W/Tone Ring T-14607-A)	13L-2-292
Part Number (7-Speed Without Tone Ring TX-14607-B)	13L-2-280
Part Number (7-Speed W/Tone Ring TX-14607-B)	13L-2-293

MAINTENANCE MANUAL

Date September 1997

SECTION 13

FULLER (RTX-13710-B)
(RTLO-14610-A)
(RTAO-14710-AS)
10-SPEED MANUAL &
SEMI-AUTO TRANSMISSION

P/N 3L-15-1458B . . . . SEPTEMBER 1997

MOTOR COACH INDUSTRIES

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SECTION 13

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MANUAL TRANSMISSION (10-SPEED)

GENERAL DESCRIPTION

Some coaches may be equipped with the Fuller® Model RTX-13710-B or RTLO-14610-A (air-assisted) 10-speed manual shift transmissions (Figure 1). These transmissions are designed with ten forward speeds, one high reverse and one low reverse gear. The RTX-13710-B series transmission is rated for engines up to 400 hp and 1,350 ft-lbs torque (1829 N·m), while the RTLO-14610-A series transmission is rated for engines up to 400 hp, and 1,450 ft-lbs torque (1936 N·m).

Additionally, the 102D series coaches may be equipped with the Fuller® Model RTAO-14710-B-AS (electronically controlled, and air-assisted) 10-speed Semi-Auto shifting transmission (Figure 2). This transmission features only one low reverse gear and ten forward gears. The RTAO-14710-B-AS transmission is rated for engines up to 400 hp and 1,450 ft-lbs torque (1936 N•m)

These transmissions feature heavy-duty cast steel housings, twin countershaft gear arrangements, fine pitch “multi-mesh” gearing, two-piece input shaft and drive gear design, repeat and nonrepeating shift patterns (manually shifted transmissions), air-actuated button operated range shifting, remote shift control and integral clutch housing release mechanism.

The manually shifted transmissions select gears via a shift linkage connecting the lever actuated master shift control to the transmission-mounted remote slave shift control box. A standard three-rail repeat shift pattern is used along with air cylinder actuated range shifting function on the RTX-13710-B, while the auto-ranging RTLO-14610-A uses an air cylinder actuated splitter gear to achieve a nonrepeat shift pattern. Refer to the “Shift Controls” for more information on the SCR master shift control and LRC remote shift control boxes and the shift linkage.

NOTE: The number of conventional lever movements with the RTLO-14610-A “Super 10” is half that of conventional ten speeds. The auto range shift feature is triggered automatically as the operator moves the lever toward the third rail.

The RTAO-14710-AS Auto-Shift Transmission is electronically controlled through the ECU mounted on the transmission and operated via the Shift Command Console located in the drivers area. The shift commands are carried out by the X-Y coordinate gear motors mounted to the top of the transmission. Range shift function is performed by solenoid-operated control valves on the range cylinder.

The optional Model RTX-13710-B “fuel saver” manual transmission may be utilized in conjunction with drive axle installations having 3.33 or 3.85 gear ratios. This combination provides for greater fuel economy. Gear ratios on the RTX-13710-B differ from the RTLO-14610-A.

COMPONENTS

COUNTERSHAFTS

Twin countershaft design divides the rated torque equally between two shafts. Because of torque splitting, each gear set carries only half the load, greatly reducing the face width of gears.

MAINSHAFT

The mainshaft assembly features the floating gear principle. These gears, when not engaged by the slide clutch gears, “float” on or between their adjacent twin countershaft gears, eliminating the need for gear sleeves and bushings.

NOTE: Only the countershaft gears which mate with multi-mesh mainshaft gears have fine pitch gearing (i.e., first and reverse gears are of the coarse pitch conventional gearing type).

HOUSING

The clutch housing mounts to the engine, and the gear case and clutch housings bolt directly to each other. The gear case provides for oil sump, fill and drain plugs, remote shift control mounting and various bearing and inspection hand hole covers.

CLUTCH RELEASE MECHANISM

The clutch housing incorporates provisions for the pull-type clutch release bearing carrier, release yoke, shafts and adjustable actuating arm. The clutch control housing incorporates lube galleries for greasing the release bearing shafts. For more information regarding the release mechanism see section 5.

ELECTRONIC CONTROL

The shift bar housing gear motors are controlled by the ECU of the control components. The ECU is attached to the transmission and connected to the engine ECU, shift selector, speed sensors and other transmission control devices through wire harness.

NOTE: Engine and transmission electronic control systems will incorporate an interface module between ECU modules.

SHIFT BAR HOUSING

The shift bar housing on manually shifted transmissions contain the shift forks that slide the clutch gears forward or backward to engage a specific gear. The LRC remote shift control is mounted to the top of the shift bar housing and actuates the shift forks.

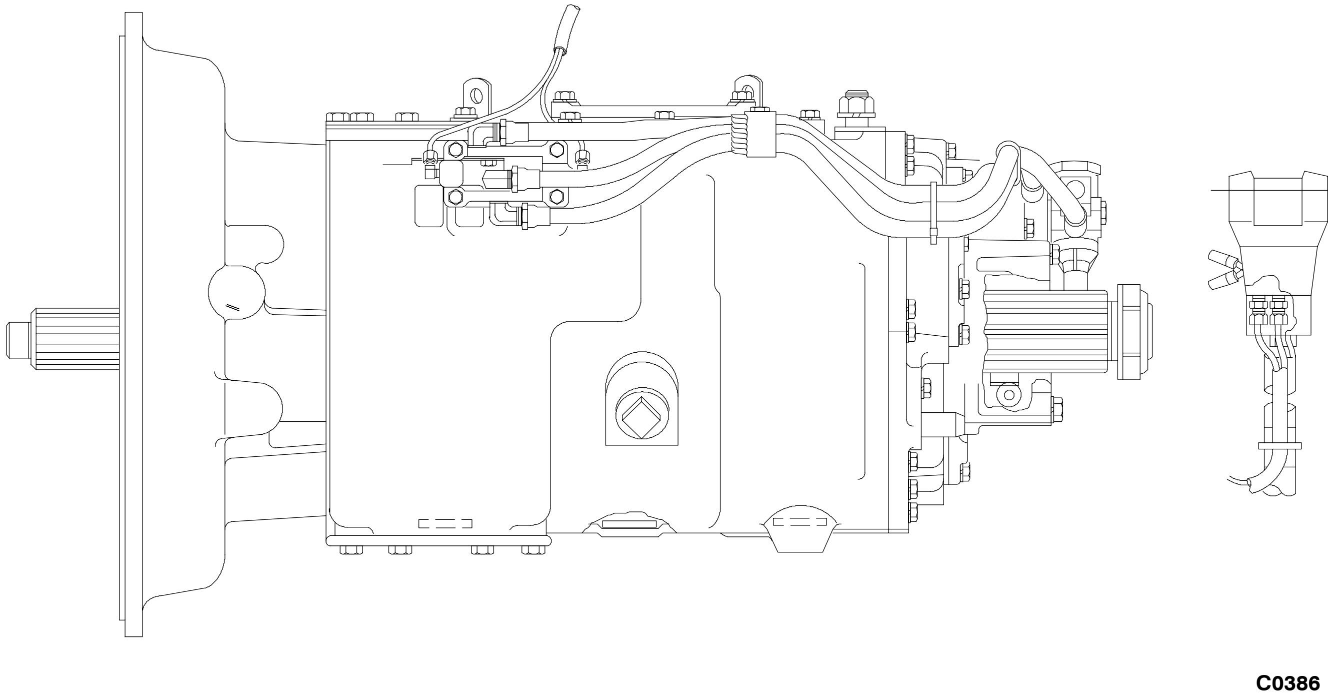

Figure 1. RTLO-14610 “Super 10” Transmission

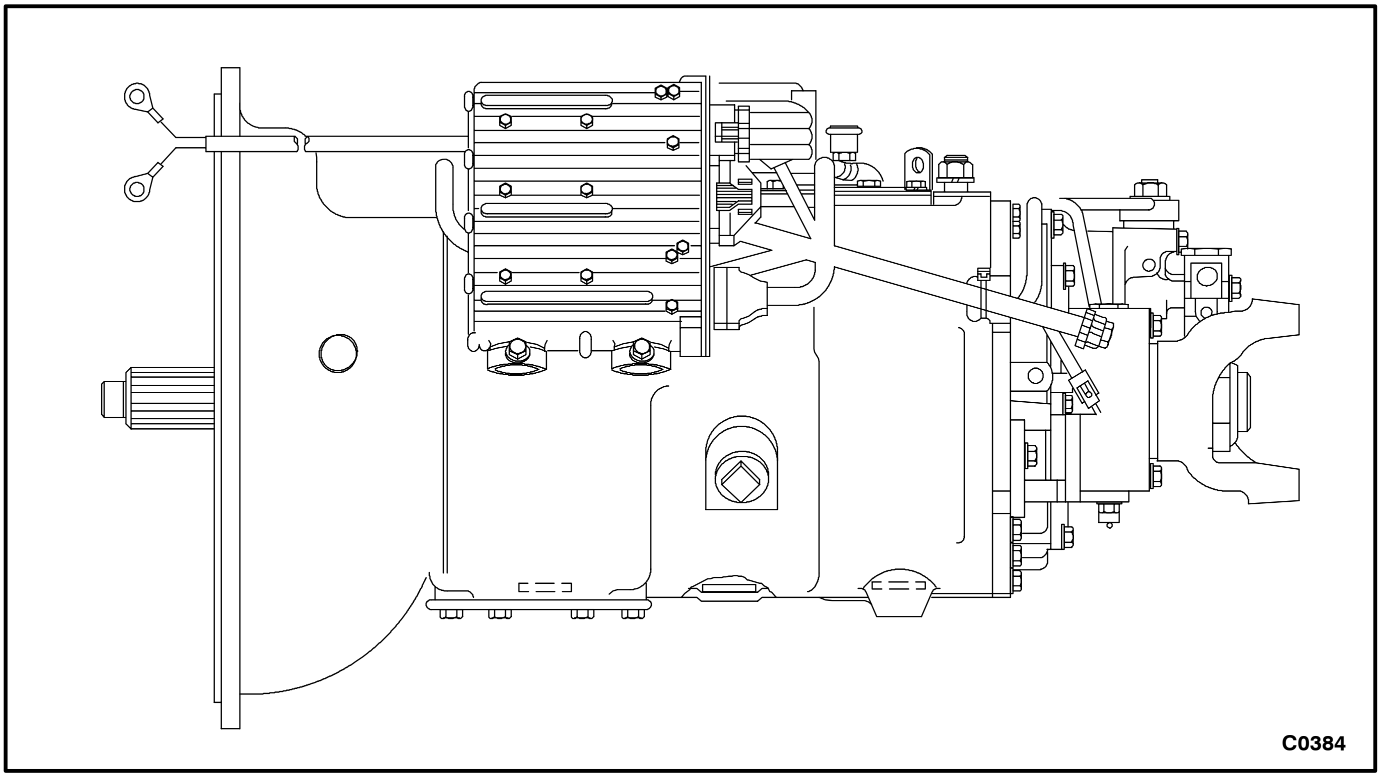

Figure 2. RTAO-14710 Auto-Shift Transmission

The shift bar housing on the electronically controlled auto shift transmission is fitted with dual electric indexing X-Y coordinates (lateral and longitudinal direction) motors that actuate the shift forks and slide the clutch gears forward or backward to engage gears. The motor commands are directed by the electronic control system ECU.

DIPSTICK & FILL TUBE

A dipstick and filler tube are installed into the transmissions for easy filling and checking of transmission lubricant. Access to the dipstick and filler tube is through the LH rear side service door.

NOTE: Effective with unit 47701 the dipstick and filler tube will no longer be installed. The fill tube hole will be plugged.

OPERATION

To convert the constant high-speed, high-torque, rotational energy of the engine into a variable speed, higher torque low-inertia rotation that can be used to move the coach, the transmission must be able to be shifted from one gear range to another. Gear shifts are accomplished through an arrangement of four fork-actuated sliding clutch gears positioned along the mainshaft of the transmission.

Input shaft rotation is transmitted to twin countershafts either side of the mainshaft. The countershafts are fitted with gears that continuously rotate a mating gear on the mainshaft. Rotating mainshaft gears are not directly coupled to the mainshaft, therefore, shaft rotation is achieved only by engagement of the slide clutch gears.

Each sliding fork of the shift bar housing is attached to one of the sliding clutch gears. As a shift fork is indexed for a specific speed via the remote shift control, the clutch gear moves to engage the inner gear of the adjacent front or rear mainshaft floating gear. Engagement into the rotating mainshaft gear causes the slide gear to rotate and turn the mainshaft and output shaft. The selection and engagement of a specific gear thereby increases or decreases the output shaft speed of the transmission.

The model RTX-13710-B and RTLO-14610-A transmissions utilize an air-actuated range control air cylinder to shift into the higher range of gears. Activation of the lever mounted air control switch allows air to flow to the range cylinder via the control valve. The cylinder is connected to the auxiliary mainshaft synchronizer assembly fork, located in the auxiliary gear case. Fork movement will option either the low or high gear ranges.

Additionally, the RTLO-14610-A uses a splitter air cylinder to shift the slide clutch gear that either engages or disengages the splitter gear, which in turn engages or disengages the front box from the rear auxiliary box and countershaft.

The RTAO-14710-B-AS auto-shift transmission's ECU receives signals from the shift console. The signals are processed and the computer controlled electric gear motors actuate the standard three-rail repeat pattern. An ECU controlled solenoid valve mounted to the air cylinder performs range shifting functions.

NOTE: The RTAO-14710-B-AS auto-shift transmission requires clutch disengagement to select the drive range of the two lowest forward gears or the reverse gear.

MAINTENANCE

PERIODIC INSPECTIONS

Every 5,000 miles (8,000 km) or 150 operating hours clean the exterior of the transmission and make the following inspections:

1. Check all transmission-to-engine mounting fasteners.
2. Check for any loose electrical harnesses or air line connections.
3. Remove filler plug or dipstick and check lube oil level. Check for any oil leaks.
4. Check for correct adjustment and operation of the shift linkage and clutch release mechanism.
5. Clean all dirt, dust and foreign objects off the shift selector module. Keep foreign objects and liquids away from shift console.

LUBRICATION

The transmissions are designed so that all internal parts including gears, bearings and shafts are either splash lubricated, or operate in an oil bath that is circulated by the motion of the gears and shafts. Always maintain proper lube oil levels to assure a protective oil film on all loaded surfaces of gears and bearings. If fluid level is too low, metal-to-metal contact which causes scoring, scuffing and seizure could occur.

NOTE: If the level is too high, oil may be forced out of the case through the mainshaft openings.

Initial Service Interval

The initial "factory fill" lubricant should be drained between the first 3,000 to 5,000 miles (4,827 to 8,045 km).

⚠ CAUTION ⚠

During initial operation tiny metal particles are freed from the mating surfaces of moving parts. The lubricant carries these particles throughout the transmission and may cause excessive wear. Remove all metal particles found on the magnetic plug(s).

Normal Service Interval

On manually-shifted Fuller models RTX-13710-B and RTLO-14610-A, the transmission oil should be changed every 50,000 miles (80,000 km) or 1,500 operating hours. Use lubrication specification S-13 (Mineral Gear Oil - MOBIL Mobilube C) or S-3 (Heavy Duty Engine Oil - MOBIL Super). In temperatures below 10 °F. use lubrication specification S-14 (Mineral Gear Oil - MOBIL Mobilube C) or S-4 (Heavy Duty Engine Oil - MOBIL Super) as shown in Section 10 of this manual.

NOTE: Other lube oils may be substituted for the manually shifted models lubrication specifications listed above. Refer to the lubricant chart to determine the correct type and viscosity required. Different types or brands of oil should not be intermixed due to the possibility of oil component breakdown.

On the auto-shifted Fuller model RTAO-14710-B-AS, the synthetic transmission fluid should be changed every 250,000 miles (402,000 km) or 7,500 operating hours. Use lubrication specification S-27 (Synthetic Manual Transmission Gear Oil - EATON Roadranger CD50 or MOBIL Mobiltrans SHC-50).

1. Operate the transmission until normal operating temperature is reached.
2. Remove the bottom drain plug(s) and drain the oil while warm.
3. Fill through dipstick tube to dipstick full level mark. On transmissions without dipstick, remove the side fill plug and refill the transmission until oil level is even with bottom of hole.
4. Thoroughly clean the plug(s) before re-installing.

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 11 of the removal procedure. A transmission dolly is available through parts outlets or may be fabricated as shown on drawing 20-233.

RECOMMENDED LUBRICANTS		
Type	**Grade (SAE)**	**Ambient Temperature**
Heavy Duty Engine Oil MIL-L-2104C or MIL-L-46152 or API-SF or API-CD	50 40 30	Above 10°F (-12.2°C) Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mineral Gear Oil with rust and oxidation inhibitor API-GL-1	90 80W	Above 10°F (-12.2°C) Below 10°F (-12.2°C)
Mid EP Gear Oil* MIL-L-2105 or API-GL-4	90 80W	10°F to 100° (-12.2°C to 38°C) -15°F to 70°F (-26°C to 21°C)
Multipurpose Gear Oil* MIL-L-2105B or MIL-L-2105C or API-GL-5	85W144 80W140 90 80W90 80W 75W	Above 10°F (-12.2°C) Above -15°F (-26°C) 10°F to 100°F (-12.2°C to 38°C) -15°F to 100°C (-26°C to 38°C) 15°F to 70° (-9.4°C to 21°C) -40°F to 15°F (-40°C to 26°C)
*Mild EP gear oil or multi-purpose gear oil are not recommended when lubricant operating temperatures are above 230°F (110°C).		

Lubricant Chart

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.

2. Drain the lubricant from the transmission, and remove the dipstick and tube if equipped.

3. Disconnect the reverse switch harness and tone ring speed sensor harness if equipped. On auto shift transmissions disconnect the engine ECU and shift module harness.

4. Loosen turnbuckle and unfasten the clutch release arm return springs.

5. Disconnect the clutch rear control cable from release arm.

6. Rotate the lever to permit the release yoke fork to turn up and pull free of the clutch release bearing.

7. Unfasten and remove the splined lever and slide release arm off shaft.

8. Disconnect the transmission air line.

9. Disconnect the driveshaft from the transmission. Refer to the "Driveshaft Removal" procedure in section 14.

10. On manually-shifted transmissions disconnect the shift linkage from the LRC remote shift control box. Refer to the "Shift Linkage Removal" procedure in section 13D.

NOTE: Unfasten the selector rod from the shift lever and pivot link rod by removing cotter keys and nuts. Do not disconnect the linkage at the turnbuckle which connects the selector lever to the linkage. This will result in maladjustment of the linkage.

11. Remove the engine and transmission module as an assembly. Refer to the "Engine Removal" procedure shown in section 8A1 thru 8A4.

12. Disconnect the transmission bottom support mounting fasteners from the engine cradle if equipped.

13. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ CAUTION ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent clutch and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the clutch discs. Failure to observe this caution will result in bending or distortion of the clutch friction discs.

NOTE: Inspect the engine-to-transmission mounting surfaces, pilot shaft bearing and bearing mount in flywheel for any signs of wear.

INSTALLATION

1. Install the transmission in reverse order of the "Removal" procedure. Refer to the "Yoke to Bearing Installation" procedure in section 5, and the "Shift Linkage Installation" procedure in section 13D when reinstalling the transmission.

MISCELLANEOUS TORQUE SPECIFICATIONS

Main Drive Gear Bearing Nut	250-300 ft-lbs
Mainshaft Rear Bearing Cover Capscrews	35-45 ft-lbs
Clutch Housing Capscrews	90-100 ft-lbs
Clutch Housing Hand Hole Cover Capscrews	20-25 ft-lbs
Front Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Rear Countershaft Bearing Cover Capscrews	35-45 ft-lbs
Oil Drain Plug	45-55 ft-lbs
Oil Fill Plug	60-75 ft-lbs
Output Shaft Yoke Nut	400-450 ft-lbs
Shift Bar Housing Capscrews	35-45 ft-lbs
LRC Remote Shift Control Housing Capscrews	35-45 ft-lbs
Reverse Signal Switch	35-45 ft-lbs

SPECIFICATIONS

TRANSMISSION ASSEMBLY

Manufacturer	Eaton/Fuller
Part Number (Model RTX-13710-B W/Tone Ring)	13L-1-106
Part Number (Model RTLO-14610-A W/Tone Ring)	13L-1-145
Part Number (Model RTAO-14710-B-AS)	13L-1-150

GEAR RATIOS - MODEL RTX-13710-B

First Gear (Model RTX-13710-B)	10.99
Second Gear (Model RTX-13710-B)	8.18
Third Gear (Model RTX-13710-B)	6.07
Fourth Gear (Model RTX-13710-B)	4.46
Fifth Gear (Model RTX-13710-B)	3.32
Sixth Gear (Model RTX-13710-B)	2.46
Seventh Gear (Model RTX-13710-B)	1.83
Eight Gear (Model RTX-13710-B)	1.36
Ninth Gear (Model RTX-13710-B)	1.00
Tenth Gear (Model RTX-13710-B)	.74
HI Reverse Gear (Model RTX-13710-B)	2.52
LO Reverse Gear (Model RTX-13710-B)	11.23

GEAR RATIOS - MODEL RTLO-14610-A

First Gear (Model RTLO-14610-A)	11.06
Second Gear (Model RTLO-14610-A)	8.20
Third Gear (Model RTLO-14610-A)	6.06
Fourth Gear (Model RTLO-14610-A)	4.49
Fifth Gear (Model RTLO-14610-A)	3.32
Sixth Gear (Model RTLO-14610-A)	2.46
Seventh Gear (Model RTLO-14610-A)	1.82
Eight Gear (Model RTLO-14610-A)	1.35
Ninth Gear (Model RTLO-14610-A)	1.00
Tenth Gear (Model RTLO-14610-A)	.74
HI Reverse Gear (Model RTLO-14610-A)	9.58
LO Reverse Gear (Model RTLO-14610-A)	12.93

SPECIFICATIONS (CONTD.)

GEAR RATIOS - MODEL RTAO-14710-B-AS

First Gear (Model RTAO-14710-B-AS)	10.99
Second Gear (Model RTAO-14710-B-AS)	8.18
Third Gear (Model RTAO-14710-B-AS)	6.07
Fourth Gear (Model RTAO-14710-B-AS)	4.46
Fifth Gear (Model RTAO-14710-B-AS)	3.32
Sixth Gear (Model RTAO-14710-B-AS)	2.46
Seventh Gear (Model RTAO-14710-B-AS)	1.83
Eight Gear (Model RTAO-14710-B-AS)	1.36
Ninth Gear (Model RTAO-14710-B-AS)	1.00
Tenth Gear (Model RTAO-14710-B-AS)	.74
LO Reverse Gear (Model RTAO-14710-B-AS)	11.23

CAPACITY SCHEDULE

RTX-13710-B	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
RTL-14610-A	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)
RTA-14710-B	Initial Factory Fill: 26 Pts. (12 L)	Service Fill: 26 Pts. (12 L)

SHIFT CONTROLS

GENERAL DESCRIPTION

Coaches equipped with the Eaton/Fuller Model RTX-13710-B or RTLO-14610-A 10-Speed manual transmission installations will feature a mechanically actuated remote shifting arrangement. The driver operated shift lever connects to a master shift control box, which is interconnected via shift linkage to the transmission-mounted remote shift control box. Each sliding fork of the transmission shift bar housing may be indexed for a specific shift via the remote shift control. The remote control box mimics the master control box shift lever selections to shift the transmission into a desired gear or range of gears.

In addition to the mechanically operated shift components, all ten-speed transmissions feature air assisted auto or manual activated range (and/or gear) shifting. Supply air is utilized to actuate specific air cylinders mounted on the transmission effecting specific reductions or auxiliary gear case activation.

The RTAO-14710-AS Auto-Shift Transmission is electronically controlled through the ECU mounted on the transmission and operated via the Shift Command Console located in the drivers area. The shift commands are carried out by the X-Y coordinate gear motors mounted to the top of the transmission. Range shift function is performed by solenoid operated control valves on the range cylinder.

NOTE: Refer to the Eaton/Fuller Service Manual when performing any repairs to the 10-speed manual or Auto-Shift transmissions.

COMPONENTS

SHIFT LEVER

The floor mounted shift lever is located to the right of the driver. The lever is connected to the SCR master shift control box. The RTX-13710-B ten-speed transmission utilizes a three rail simple repeat pattern (Figure 4), while the RTLO-14610-A “super 10” ten-speed features a three rail non-repeat pattern (Figure 5).

SHIFT SELECTOR MODULE

The auto shifted 10-speed transmissions utilize a shift by wire system consisting of the Eaton Driver Command Console (DCC) selector control module. This module is connected to the transmission ECU by harness. The shift selector control module may use either lever-actuated or touch pad type control (Figure 3).

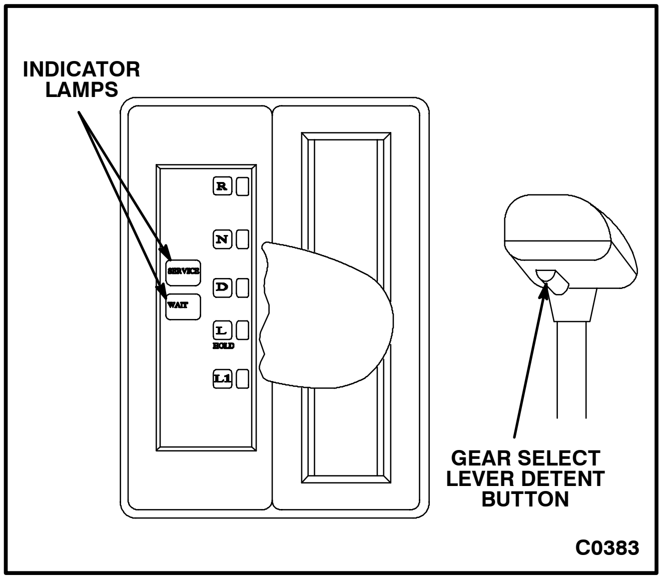

Figure 3. 10-Speed Auto-Shift

The air assisted ranging function is optioned by the shift lever knob air control valve button. Activation of the air control valve button allows air to flow to the control port of the air valve and on to the range cylinder. Similar air control components are used to shift the auxiliary gear case of the auto-ranging “super 10” transmissions; however, a second splitter cylinder is also actuated.

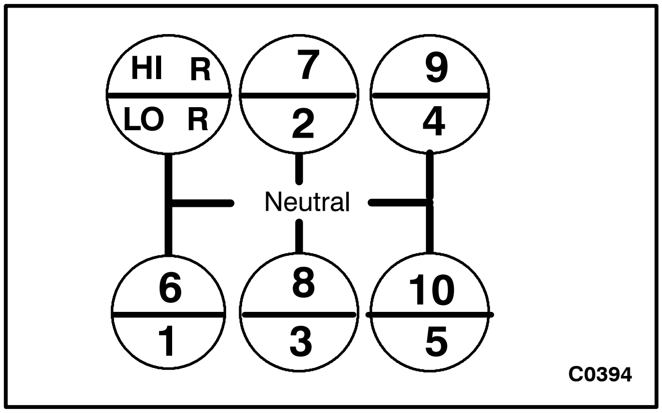

Figure 4. 10-Speed Repeat Shift Pattern

MASTER SHIFT CONTROL

The SRC master control box is located beneath the floor mounted shift lever. The master control transmits the movements of the shift lever to the shift linkage.

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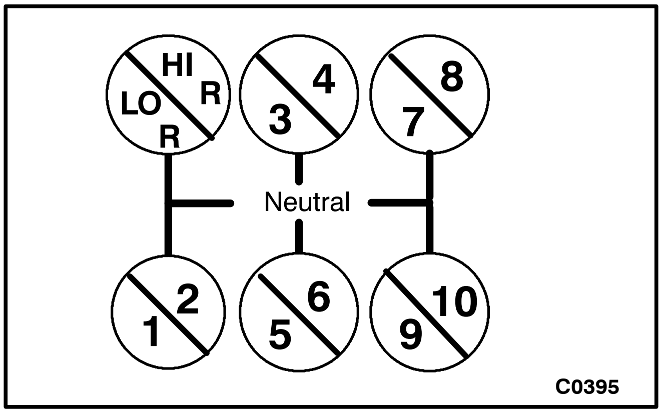

Figure 5. 10-Speed Non-Repeat Shift Pattern

SHIFT LINKAGE

The shift linkage runs the length of the coach within the center tunnel. The linkage transmits the movements of the shift lever to the selector lever of the remote shift control box. A turnbuckle adjustment is incorporated at the rear of the linkage for positive shifting.

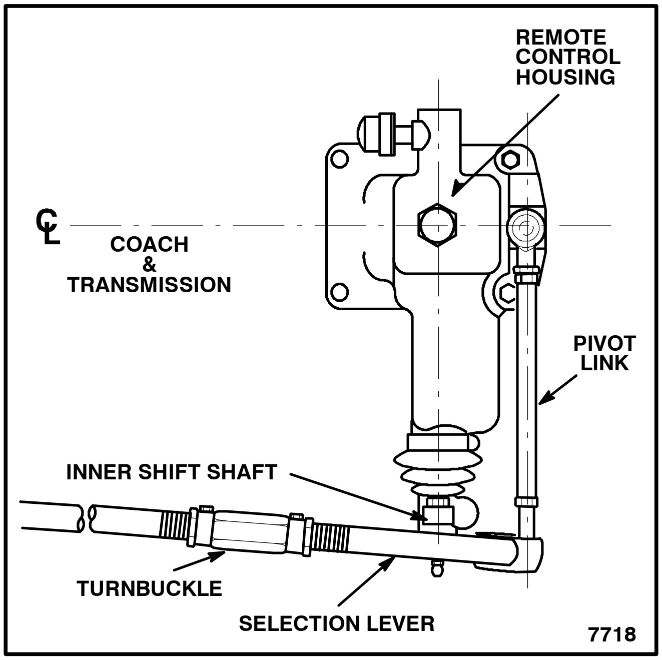

Figure 6. Remote Box Shift Linkage

REMOTE SHIFT CONTROL

The LRC remote shift control is mounted to the top of the shift bar housing. The shift linkage is attached to a threaded selector lever, which in turn is connected to the inner shift shaft of the remote control box via a shift lever. The selector lever is also connected to a stationary pivot link assembly that keeps selector lever in proper alignment (Figure 6). The inner shift shaft is fitted with the inner shift finger that controls shift fork function.

RANGE CYLINDER

The model RTX-13710-B and RTLO-14610-A transmissions utilizes an air actuated range control air cylinder to shift into the higher range of gears. Activation of the lever mounted air control switch allows air to flow to the range cylinder via the control valve. The cylinder is connected to the auxiliary mainshaft synchronizer assembly fork, located in the auxiliary gear case. Fork movement will option either the low or high gear ranges.

SPLITTER CYLINDER

Additionally, the RTLO-14610-A uses a splitter air cylinder to shift the slide clutch gear that either engages or disengages the splitter gear, which in turn engages or disengages the rear auxiliary box and countershaft to the front box.

CONTROL VALVE

Both the model RTX-13710-B and the RTLO-14610-A uses an air cylinder control valve to route air to a specific cylinder during transmission operation. Both valves receive supply air from the filter regulator attached to the rear of the transmission. Control port air is supplied through the master air control valve located on the shift lever. The RTLO-14610-A control valve is mounted to the top of the transmission, while the RTX-13710-B valve is mounted on the side.

MAINTENANCE

LUBRICATION

Lubrication of the entire shift linkage is recommended at 75,000 mile (121,000 km) or 2,250 operating hours. Lubricate the master and slave shift control boxes, carrier bearings, U-joints and all ball joints of the linkage through the grease fittings provided. Use lubrication specification S-16 (Multi-Purpose Grease - MOBIL-MOBILITH AW-1).

NOTE: Front U-joints and bearing lube fittings are accessed through the front bogie fitting and tire compartment, while the rear U-joint and bearings are accessed at the rear bogie cover.

ADJUSTMENT

Proper adjustment of the LRC remote control shift linkage is necessary for smooth shift operations. When adjusting the shift linkage, follow the procedures outlined below in order to insure that the linkage is set properly for smooth and trouble-free operation.

Slave Control Linkage

1. Place battery disconnect switch “Off”. Apply the parking brake.

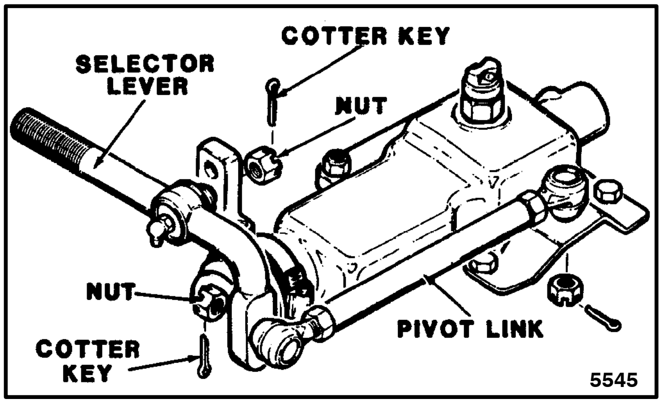
COTTER KEY
SELECTOR LEVER
NUT
NUT
PIVOT LINK
COTTER KEY
5545

Figure 7. Disconnecting Shift Linkage

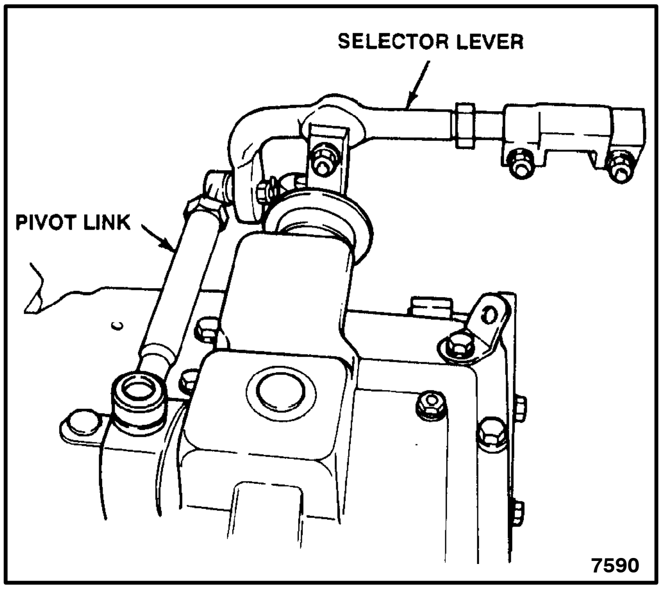
SELECTOR LEVER
PIVOT LINK
7590

Figure 8. Selector Lever to Shift Arm

2. Move the gear shift lever forward or backward to place inner shift finger in the neutral position.

3. Move the the gear shift lever sideways, towards reverse, until resistance from the reverse plunger spring is felt. Do not overcome this spring tension, and leave the inner shift finger in this position while making adjustments.

4. Unfasten and remove the pivot link cotter pin, castle nut and ball joint from the selection lever (Figure 7). Do not remove the ball joint from the pivot link.

5. Unfasten and remove the capscrew retaining the shift arm to the inner shift shaft. Do not disconnect the selection lever from the shift arm (Figure 8).

6. Turn the shift arm until it is at a right angle (90 degree) to the selection lever as viewed from the side (Figure 9).

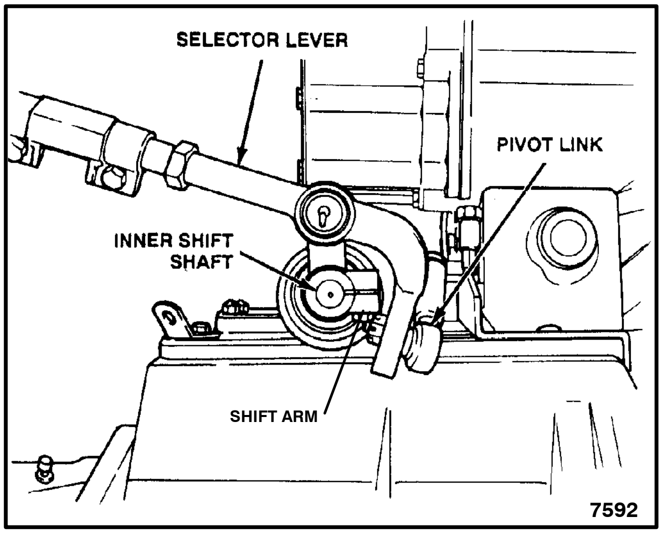
SELECTOR LEVER
PIVOT LINK
INNER SHIFT SHAFT
SHIFT ARM
7592

Figure 9. Linkage Components

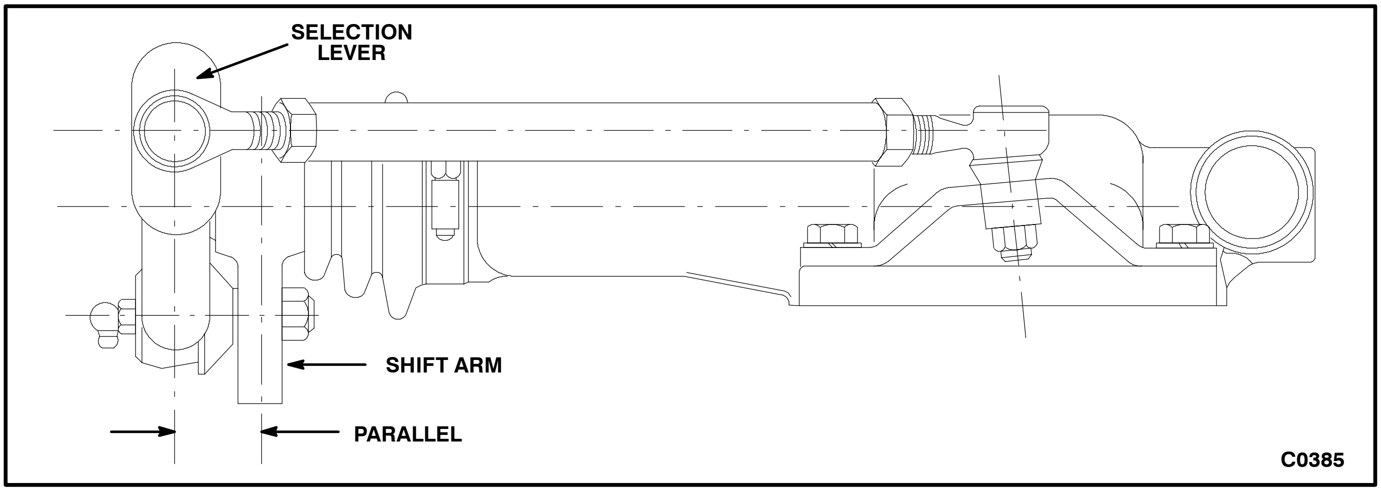
SELECTION LEVER
SHIFT ARM
PARALLEL
C0385

Figure 10. Pivot Link Alignment

NOTE: Ideally, the shift arm should be adjusted 90° to the selection lever as described, but in some chassis configurations it may be necessary to index the shift arm in the vertical position. This is done to prevent a "shift lever jump out condition". This type adjustment will cause an unequal amount of gear shift lever travel between neutral and a forward lever position as compared to a neutral to rearward lever position.

7. Reinstall the shift arm on the splines of the inner shift shaft and tighten. The shift arm may have to be moved 4 or 5 degrees to align the splines of the two parts.

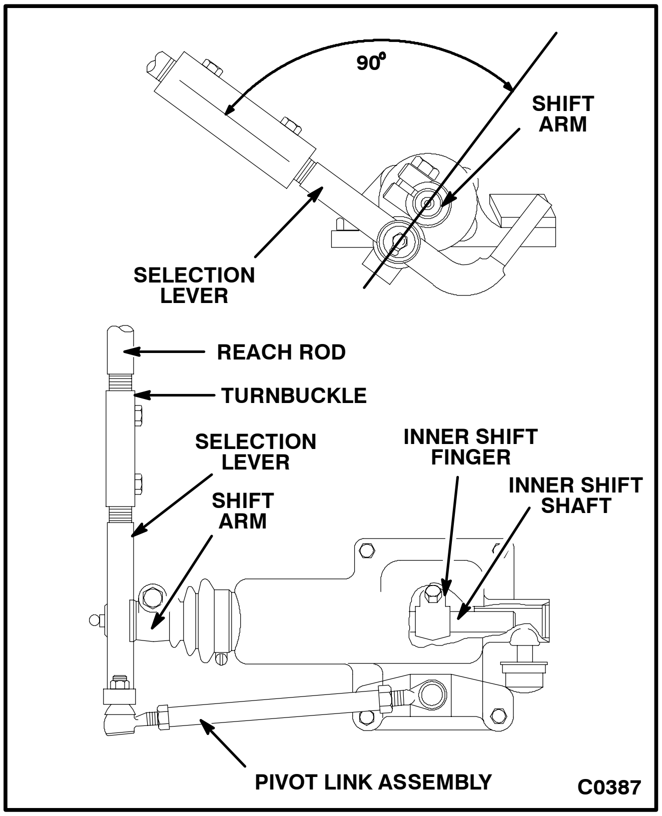

Figure 11. Components

8. Reconnect pivot link assembly ball joint to selection lever and secure.

9. Loosen the jam nuts on both ends of the pivot link, and rotate pivot link until curved end of selection lever is parallel with the shift arm as viewed from the rear (Figure 10).

NOTE: Inner shift finger must still be positioned as described in steps 1 and 2.

Shift Lever (Neutral)

1. Loosen both capscrews on the turnbuckle linear adjustment at rear linkage reach rod to selection lever (Figure 11).

NOTE: Again, check that inner shift finger is still positioned as described in steps 1 and 2 of the previous adjustment procedure.

2. Rotate turnbuckle to obtain the proper forward or rearward (neutral) position of the gear shift lever.

3. Tighten one of the turnbuckle clamp capscrews to secure this adjustment.

4. Move the gear shift lever to the desired left-right (neutral) position, and tighten the second turnbuckle clamp capscrew.

5. Check for any linkage interference, binding or obstruction in all gear shift positions.

REMOVAL

Rear Linkage

1. Unfasten the rear selector lever from the shift arm and pivot link rod by removing cotter keys and nuts.

2. Loosen both capscrews on the turnbuckle at rear shift linkage and turn off rear shift control rod to remove.

NOTE: Do not disconnect the linkage from the turnbuckle which connects the selector lever to the linkage rear shift rod. This will result in maladjustment of the linkage at reinstallation.

3. Unfasten and remove the pivot link from the transmission mount bracket.

4. Unfasten and remove the shift arm from the inner shift shaft splines.

5. Remove the rear bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

6. Unfasten and remove the rear U-joint and shift rod assembly at its connection with the center tunnel shift tube.

7. Unfasten and remove the flange mounted rear shift tube carrier bearing.

Front Linkage

1. Unfasten the shift lever boot and cover drivers floor and pull shift lever from master shift control box.

NOTE: Shift levers with air control buttons must have master control knob disassembled and removed from shift lever.

2. Unfasten and remove the front U-joint and master shift control box at its connection with the front of first shift rod.

NOTE: Further access for disassembly and removal of the shift linkage requires that the center aisle ramp or the front bogie closing panel and the #1 baggage bay center tunnel closing panels be removed.

3. Unfasten and remove the front tire compartment rear panel plate and boot assembly.

4. Remove either the ramp or front bogie cover panel, and disconnect the U-joint and carrier bearing lube lines.

5. Unfasten and remove the U-joint and first shift rod assembly at its connection with the second (ramp) shift rod.

6. Unfasten and remove the flange-mounted front shift rod carrier bearing from the front of the second shift rod.

7. Remove the center tunnel cover panel, and disconnect the rest of the U-joint and carrier bearing lube lines.

8. Unfasten and remove the U-joint and second shift rod assembly at its connection with the center tunnel shift tube.

9. Unfasten and remove the flange mounted intermediate shift rod carrier bearing from the front of the shift tube assembly.

NOTE: Shift tube may be removed in pieces by cutting.

INSTALLATION

1. Reassemble and install in reverse order of “Removal” procedure and readjust the linkage.

SPECIFICATIONS

SRC MASTER SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number	13L-7-170

LRC SLAVE SHIFT CONTROL

Manufacturer	Fuller/Eaton
Part Number	13L-2-409

SECTION 13

ALLISON (HT-700 SERIES) AUTOMATIC TRANSMISSION

SECTION 13

AUTOMATIC TRANSMISSIONS (HT-700 SERIES)

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TRANSMISSION ASSEMBLY

GENERAL DESCRIPTION

Some coaches may be equipped with the four- or five-speed close-ratio Allison HT-740-D, HT-754 heavy-duty hydraulically-shifted transmissions. Other coaches may be equipped with the Allison HT-741, HT-746, HTB-748 (output retarder) or HT-755 four-speed and five-speed ATEC transmissions. These transmissions feature manually shifted range selection (via shift lever or touch pad selector module), lockup torque converter assembly, triple planetary gear setup, remote mounted oil cooler assemblies (depending on engine installation) and the (ATEC) Electronic Control System.

This section will address general service and lubrication procedures for all of these transmissions. Additional detailed service procedures for all Allison HT-700 series automatic transmissions may be found in the applicable Allison Transmission Service Manuals.

COMPONENTS

TORQUE CONVERTER

The torque converter consists of three elements which are the pump, turbine and stator assemblies. The pump is the input element and is driven directly from the engine. The turbine is the output element and is hydraulically driven by the pump. The stator is a reaction (torque multiplying) element. When the pump turns faster than the turbine, the converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. When this occurs, torque multiplication stops and the converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of three elements which are the piston, clutch plate/damper and a back plate. The piston and back plate are driven by the engine. The clutch plate/damper, located between the piston and the back plate, is splined to the converter turbine.

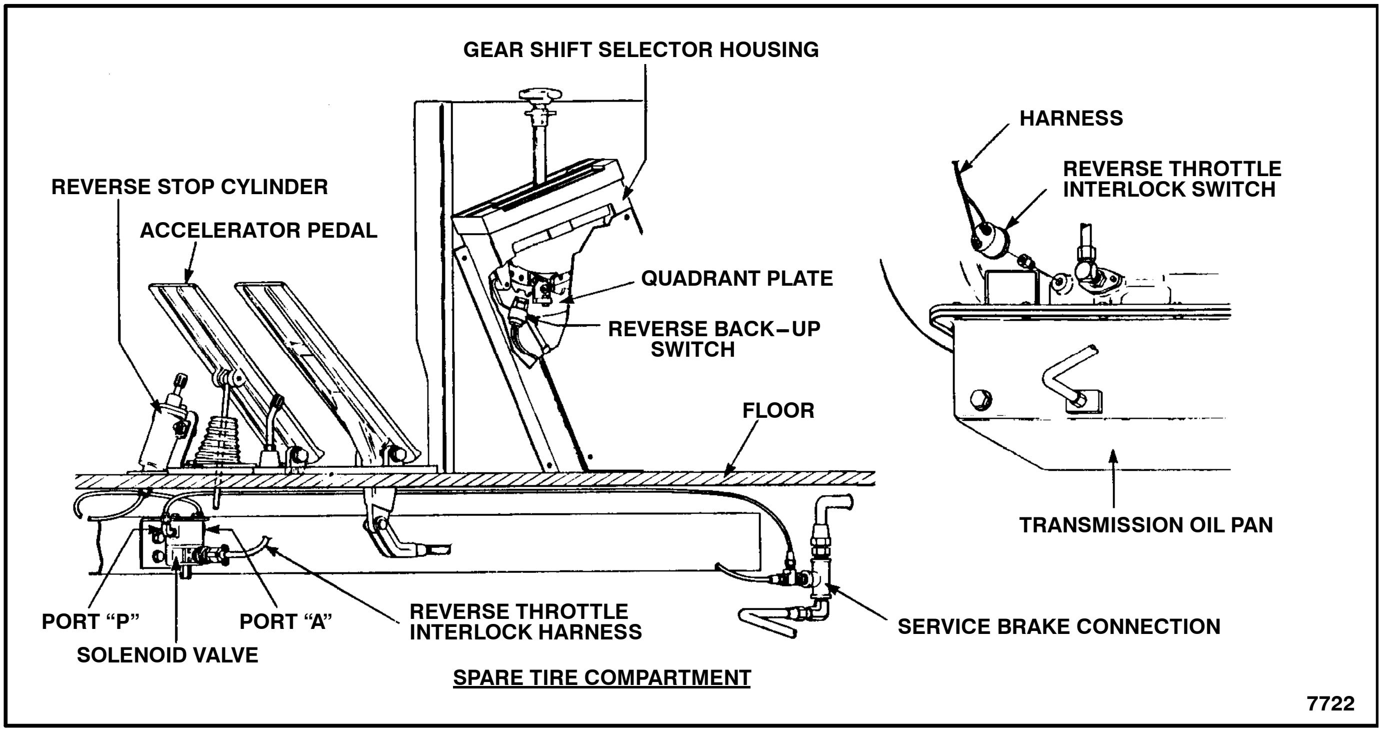


Figure 1. Reverse Throttle Interlock Installation

The lockup clutch is engaged and released in response to electronic commands from the ECU. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The torsional dampening feature absorbs engine vibration.

PLANETARY GEARS & CLUTCHES

A series of three planetary gear sets and shafts provide the gear ratios and direction of travel for the coach. The planetary gear sets are controlled by four multi-plate clutches that work in pairs to produce the four speeds. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate combination of clutch solenoids.

ATEC ELECTRONIC CONTROL SYSTEM

The ATEC Electronic Control System consists of five major components connected by wiring harness. These components are the Electronic Control Unit (ECM), engine throttle position sensor (or direct electronic communication as provided by the electronic accelerator pedal), speed sensor, shift selector and the transmission's internal control module (which contains the solenoid valves and pressure switch). For more information on the ATEC system, refer to section 13B6.

The throttle position sensor, speed sensor, pressure switch, and shift selector transmit information to the ECU. The ECU processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

COOLER CIRCUIT

The transmission fluid is cooled by the engine oil cooler. Connections for this cooling circuit are located at the front of the transmission housing to facilitate installation of lines.

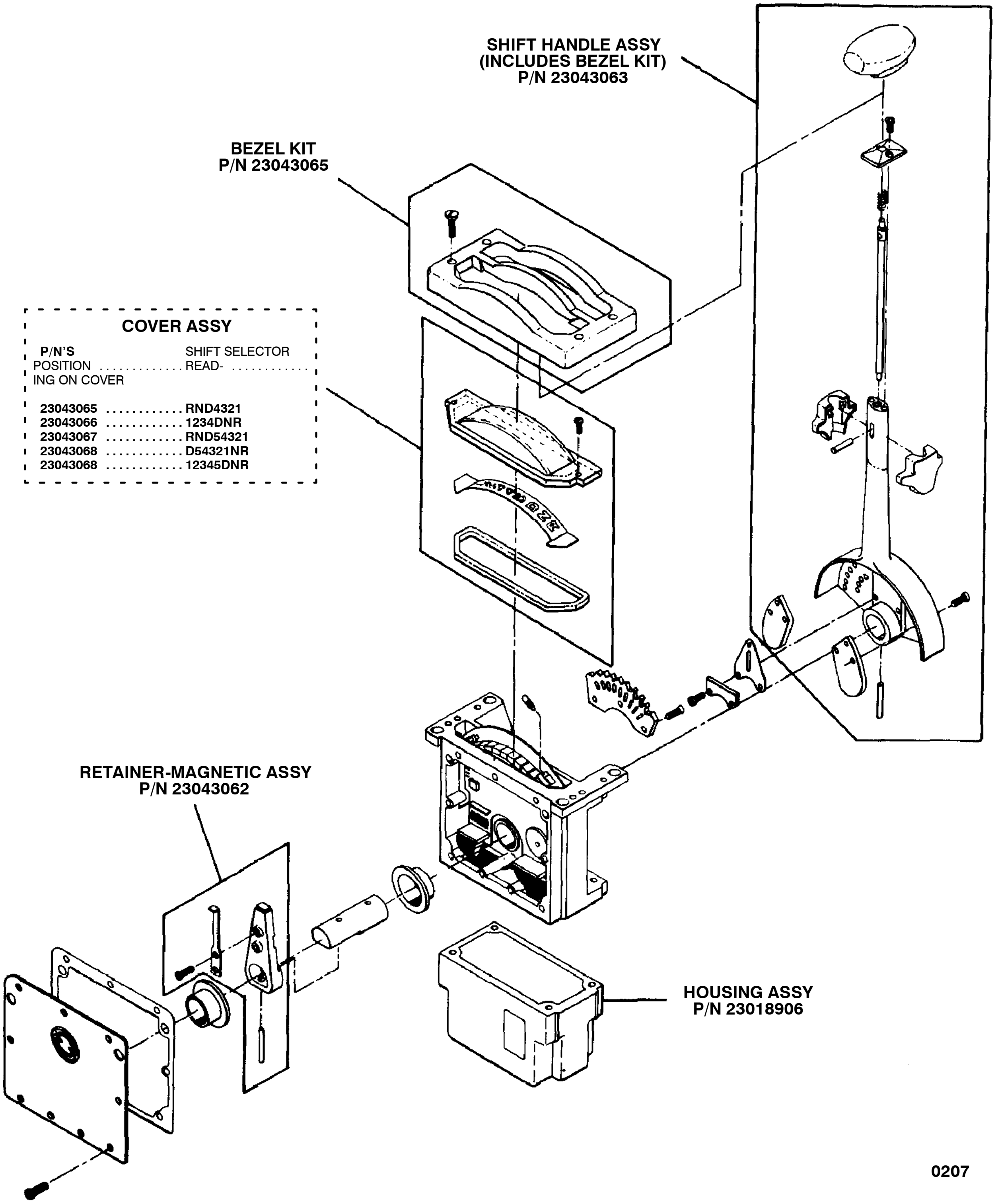
SHIFT MODULATOR

An air-actuated transmission shift modulator valve is installed on the HT-740-D and HT-754 automatic transmissions when coupled with the (DDEC) electronically controlled engines.

NOTE: A cable-actuated modulator valve was used on non-electronically controlled engine installations prior to 1992 production.

The shift modulator is a single-acting, non-repairable, pneumatic cylinder which provides the transmission shift signal valves with a regulated pressure proportional to the throttle position in order to control the transmission shift function.

Air to operate the modulator valve is supplied from the air manifold which is mounted on the right-hand side of the engine compartment ceiling. A Skinner valve controls the air flow from the manifold to the modulator (Figure 6). The Skinner valve is actuated by signals from the engine's electronic control module.


SHIFT HANDLE ASSY
(INCLUDES BEZEL KIT)
P/N 23043063
BEZEL KIT
P/N 23043065
COVER ASSY
RETAINER-MAGNETIC ASSY
P/N 23043062
HOUSING ASSY
P/N 23018906
0207

P/N'S POSITION	SHIFT SELECTOR READING ON COVER
23043065	RND4321
23043066	1234DNR
23043067	RND54321
23043068	D54321NR
23043068	12345DNR

Figure 2. Shift Selector Repair

REVERSE THROTTLE INTERLOCK

In order to avoid drive axle gear damage caused by driver abuse, a reverse throttle interlock is provided for coaches with automatic transmissions (Figure 1). This feature prevents high-speed reverse gear engagement.

Refer to the appropriate wiring diagram in the “Wiring Schematics” located in Section 7J of the MCI Maintenance Manuals for details of the reverse throttle interlock feature.

SHIFT SELECTOR

MECHANICAL SHIFT

The HT-740, HT-754 four and five speed transmissions are hydraulically auto-shifted once placed into the desired shift range. The shift range selections are made through the manually operated shift control lever located on the floor console to the right of driver (Figure 2).

ATEC SHIFT

The electronically controlled hydraulic auto-shifting of the HT-741, HT-746 HTB-748 and HT-755 four and five-speed (ATEC) transmissions are totally automatic. The shift range selections are made through a touch-pad module shift selector control located on the floor console to the right of the driver (Figure 3 & 4).

PERIODIC INSPECTIONS

Clean and inspect the exterior of the transmission at regular intervals. Severity of the service conditions will determine the frequency of these inspections. Some of the more common inspections would focus on the following conditions:

A. Loose fasteners on the transmission and mounting components.

B. Improper fluid levels or fluid leaks.

C. Damaged or loose cooler hoses.

D. Worn, stretched or improperly routed shift selector cable.

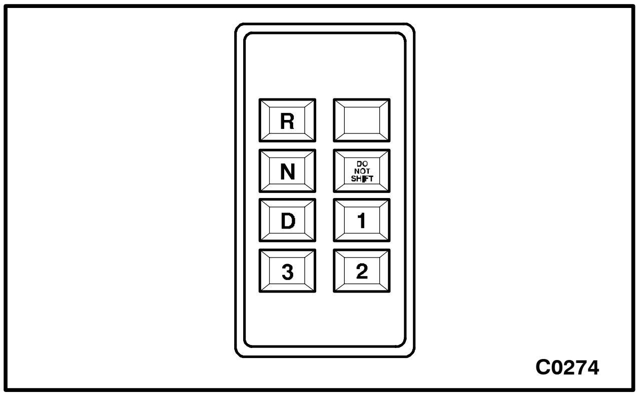


Figure 3. Four Speed Shift Selector

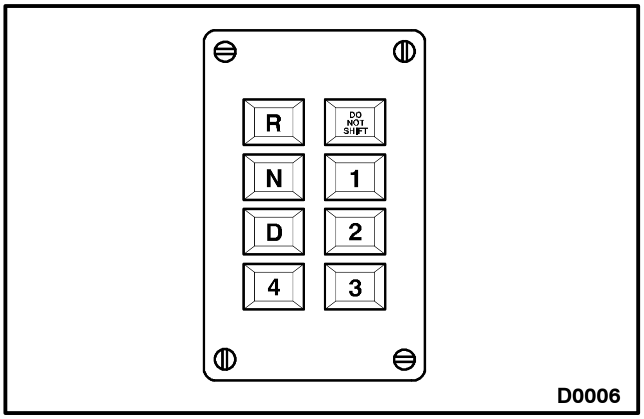


Figure 4. Five Speed Shift Selector

MAINTENANCE

E. Loose, dirty or improperly adjusted transmission modulator assembly.

F. Worn or improperly routed electrical harnesses.

G. Loose, dirty, or improperly adjusted electronic throttle sensor.

CONTROL ADJUSTMENTS

MODULATOR AIR REGULATOR

The Williams air actuated modulators used on all electronically controlled engine installations are non-adjustable. However, the regulator must be set at the correct Skinner valve delivery pressure of 70 psi.

MODULATOR LINKAGE

The mechanically actuated modulator linkage of the non-electronically controlled engines should be properly adjusted for efficient shift performance.

1. Place the fuel control lever of the engine at full throttle position.

2. Place the mechanical actuator cable at full throttle position against the mechanical stop.

3. Adjust the clevis at the fuel control lever so the pin fits freely through the hole in clevis, making sure the lever is secure. Total cable travel should not be less than 1.187 inches (30.14 mm) or more than 1.56 inches (39.62 mm).

SHIFT SELECTOR CABLE

The shift cable has several points of adjustment. An adjustment of approximately 1” can be made at the shift selector lever cable clamp. Another adjustment of 2” may be made at the rear cable mounting bracket.

> **NOTE:** Additional minor cable adjustments can be made at the front rod end and rear pivot ball end. Front and rear rod end turnbuckles must be threaded onto cable at least 1 and 1/2 times the rod diameter.

1. Loosen shift selector cable clamp fasteners and adjust cable to desired position and retighten.

2. Loosen both hex jam nuts on rear cable mounting and adjust cable to desired position and retighten.

LUBRICATION

The transmission fluid cools, lubricates and transmits hydraulic power. Always maintain proper fluid levels. If fluid level is too low, the torque converter and clutches do not receive an adequate supply of fluid and the transmission overheats. If the level is too high, the fluid aerates causing the transmission to shift erratically and overheat. Fluid may be expelled through the breather or dipstick tube when fluid level is too high.

Transmission fluid level should be checked daily first by the manual cold check procedure. Transmission hot fluid level can be checked manually after transmission has reached operating temperature. Check the fluid level using the following procedures and record in a maintenance log.

⚠ **WARNING** ⚠

When checking the fluid level by the manual method, be sure the transmission is in neutral, the park brake is applied and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

FLUID LEVEL CHECK

Manual Cold

The purpose of the cold check is to determine if the transmission has enough fluid to be operated safely until a hot check can be made. Always check the fluid level reading with the engine running and at least twice.

1. Park vehicle on a level surface.

2. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.

3. Run the engine for at least one minute. apply the service brakes, shift transmission to drive (D) and operate engine at 1000 to 1500 rpm for 30 seconds; then shift to reverse (R) to clear the hydraulic system of air. Finally, shift into neutral (N) and allow the engine to idle (500-800 rpm).

4. With engine still running, remove the dipstick from the tube and wipe clean.

5. Insert the dipstick into tube and remove. Check the level reading.

6. Repeat the check to verify the reading.

7. If the fluid level is within the “COLD RUN” band on the dipstick, the transmission may be operated until the fluid is hot enough to perform a “HOT RUN” check. If the fluid level is not within the limits of the band, add as necessary to bring to the middle of the band.

8. Perform a hot check at the first opportunity after the normal operating temperature is reached.

Manual Hot

1. Operate the transmission in drive (D) range until normal operating temperature is reached.

NOTE: Normal operating sump temperature is in the 160-200°F (71-93°C) range. Normal operating converter-out temperature should be in the 180-220°F (82-104°C) range.

2. Park vehicle on a level surface, and allow engine to idle (500-800 rpm).

3. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.

4. Insert the dipstick into tube and remove. Check the level reading.

5. Repeat the check to verify the reading.

6. If the fluid level is not within the limits of the “HOT RUN” band, add as necessary to bring to the middle of the band.

NOTE: Do not allow dirt or foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of internal components.

NOTE: Consistency is important to maintaining accuracy of the reading in a manually checked level. If inconsistent readings persist, check the transmission breather to be sure it is clean and unclogged.

SPECIFICATION

Hydraulic fluids used in the HT-746 transmissions are important influences on transmission performance, reliability and durability. All lube oil fluids must qualify to Allison’s Type C-4 specification if not specifically designated as torque fluids like DEXRON IIE and/or DEXRON III. DEXRON IIE and/or DEXRON III fluids are recommended for most coach automatic transmission service conditions.

The minimum safe operating temperature of DEXRON IIE and/or DEXRON III fluids is -17°F. Sump fluid temperatures below this minimum must be preheated by running equipment with transmission in neutral for approximately 20 minutes before shifting into range operation.

NOTE: Sump temperature must be between 60-120°F (16-49°C) range.

⚠ CAUTION ⚠

Prevent foreign material from entering the transmission by using clean containers, fillers, etc. and by keeping dipstick clean. Containers or fillers that have been used for antifreeze solution or engine coolant must never be used for transmission fluids.

NOTE: Antifreeze and engine coolants contain ethylene glycol. When introduced into transmissions, even small amounts of ethylene glycol can cause clutch plates to fail.

INITIAL SERVICE INTERVAL

The initial factory fill should be drained and the filters changed after the first 5,000 miles (8,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

PERIODIC SERVICE INTERVAL

Drain and change the filters every 25,000 miles (40,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Remove the drain plug from the oil sump pan, and allow the fluid to drain completely.

NOTE: It is not necessary to drain the fluid if only the filters are to be replaced.

3. Remove and discard filter element by turning counter-clockwise (Figure 5).

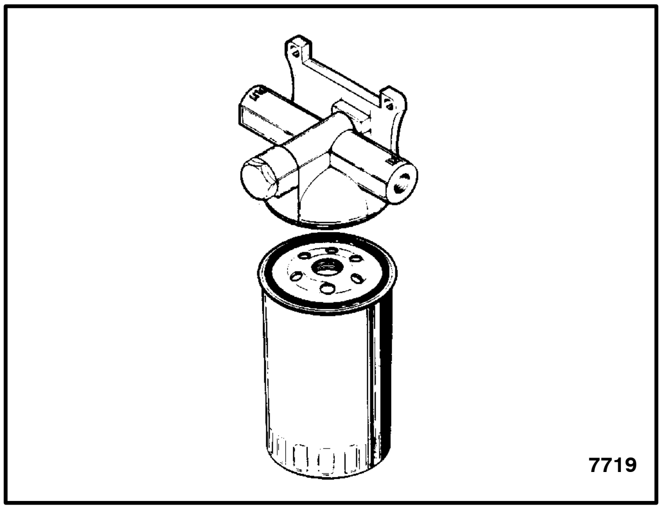


Figure 5. Automatic Transmission Filter

4. Thoroughly clean any dirt or oil from the base casting.

5. Install new element and tighten approximately 2/3 turn beyond first contacts with base.

6. Refill the transmission and check the fluid level using the manual fluid check procedures.

NOTE: The amount of refill fluid will be less than the amount used for the initial factory fill. Fluid should remain in the external cooler circuits, torque converter and transmission cavities after draining. Refer to the capacity schedule in specifications portion of this section for exact fluid quantities used in the HT-746 transmissions.

MODULATOR REPLACEMENT

The cable actuated and air actuated modulators have different “Removal” and “Installation” procedures.

REMOVAL

Air Actuated

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Disconnect the modulator air hose from Skinner valve (Figure 6).

3. Unfasten the exterior modulator retainer clip capscrew and remove the modulator from transmission.

Cable Actuated

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Unfasten and remove the modulator actuator cable from engine throttle assembly.

3. Unfasten the exterior modulator retainer clip capscrew and remove the modulator from transmission.

INSTALLATION

Air Actuated

1. Remove protective covers from transmission and/or modulator valve.

NOTE: If applicable, make certain modulator valve spacer pin is in place (supplied with transmission). Ensure that the O-ring is in place on the modulator valve.

2. Lubricate shaft with transmission fluid, and Insert modulator valve into transmission.

3. Place retaining clip in groove on valve housing and torque capscrew to 15-20 ft-lbs (20-27 N·m) torque.

4. Adjust the transmission modulator’s regulator valve to 70 psi.

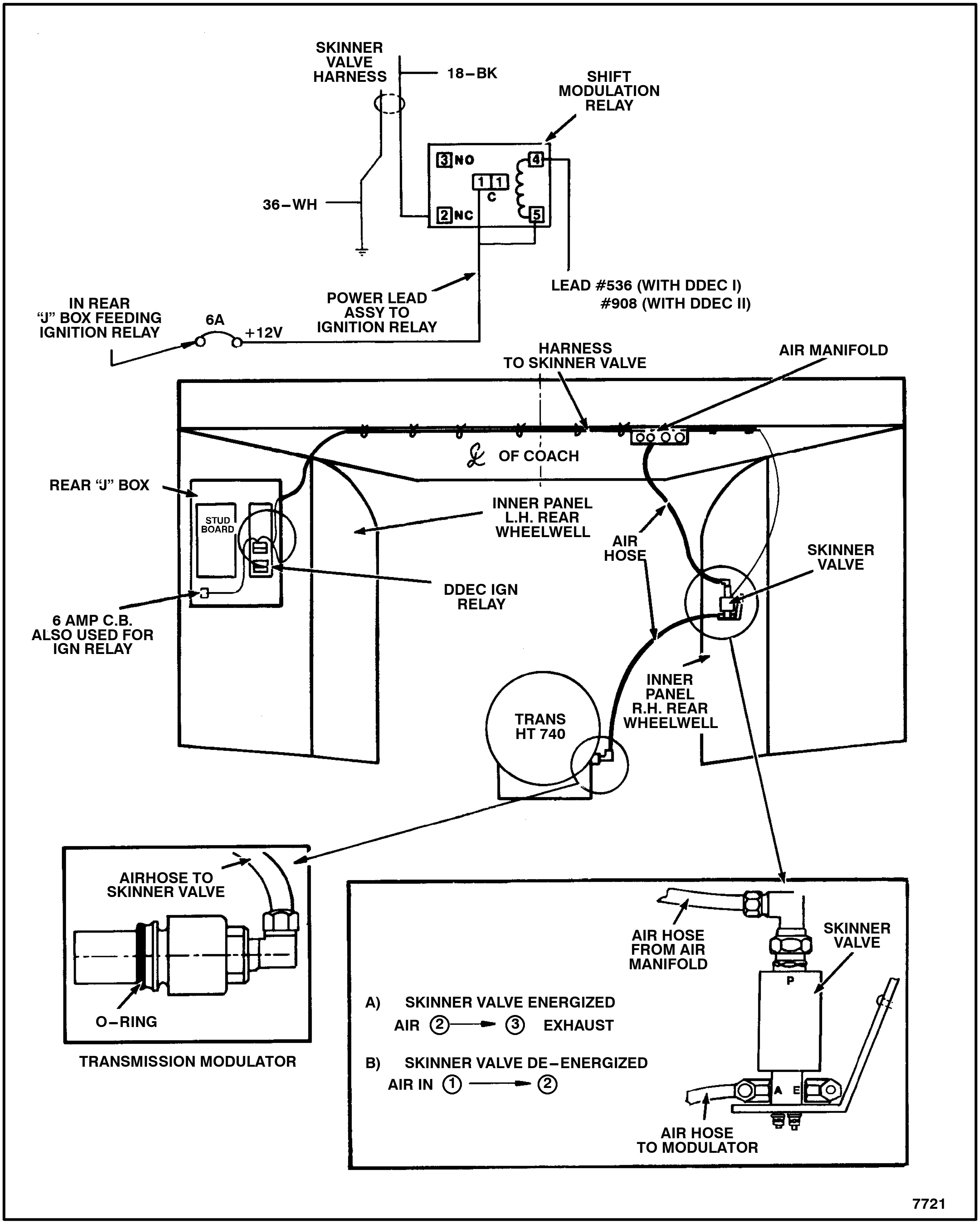

SKINNER VALVE HARNESS
18–BK
SHIFT MODULATION RELAY
3 NO
1 1
C
4
2 NC
5
36–WH
POWER LEAD ASSY TO IGNITION RELAY
LEAD #536 (WITH DDEC I)
#908 (WITH DDEC II)
IN REAR "J" BOX FEEDING IGNITION RELAY
6A
+12V
HARNESS TO SKINNER VALVE
AIR MANIFOLD
℄ OF COACH
REAR "J" BOX
STUD BOARD
INNER PANEL L.H. REAR WHEELWELL
AIR HOSE
SKINNER VALVE
DDEC IGN RELAY
6 AMP C.B. ALSO USED FOR IGN RELAY
INNER PANEL R.H. REAR WHEELWELL
TRANS HT 740
AIRHOSE TO SKINNER VALVE
O–RING
TRANSMISSION MODULATOR
AIR HOSE FROM AIR MANIFOLD
SKINNER VALVE
P
A) SKINNER VALVE ENERGIZED
AIR ② ⟶ ③ EXHAUST
B) SKINNER VALVE DE–ENERGIZED
AIR IN ① ⟶ ②
A
E
AIR HOSE TO MODULATOR
7721

Figure 6. Modulator Installation (DDEC Engines)

Cable Actuated

1. Follow steps 1 thru 3 of previous procedure.
2. Route cable and secure to pivot arm on governor.
3. Rotate the governor pivot lever to the full throttle position.
4. Check linkage for proper return to idle position, and check adjustment with the previous "Adjustment" procedure.
5. Pull the cable until it is internally bottomed. Adjust trunnion on end of cable to permit a "free pin" with fuel control lever in full fuel position. Install and secure pin.

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 9 of this removal procedure. A transmission dolly is available through parts outlets or may be fabricated. See "Service Tools" at end of this section.

1. Place battery disconnect switch "Off". Apply the parking brake and block vehicle wheels.
2. Drain the fluid from the transmission, and remove the dipstick and tube.
3. Disconnect all electrical harnesses from the transmission.
4. Disconnect the modulator actuator cable or air line from the transmission.
5. Disconnect the shift control cable from the transmission shift lever.
6. Disconnect any remote oil filter lines at the transmission.
7. Disconnect the driveshaft from the transmission. Refer to the "Driveshaft Removal" procedure in section 14.
8. Remove the engine and transmission module as an assembly. Refer to the "Engine Removal" procedure shown in section 8A1 thru 8A4.
9. Support the rear of the engine with jack stands, and unfasten and remove the mounts and brackets attaching the transmission to the engine cradle.
10. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ CAUTION ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent torque converter and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the torque converter. Failure to observe this caution will result in damage to the transmission and/or torque converter.

NOTE: Inspect the engine-to-transmission mounting surfaces and flex plates for any signs of wear or damage.

INSTALLATION

1. Install the transmission in reverse order of the "Removal" procedure.

ELECTRONIC CONTROL SYSTEM

GENERAL DESCRIPTION

The Allison automatic transmissions installed on 102D series coaches utilize Allison Transmission Electronic Control (ATEC) electronic control systems. The electronic control systems governs the upshift, downshift, lock-up and fault lock-in functions of transmission operation, including operations in less than nominal operating conditions.

NOTE: The control system monitors itself for fault conditions and/or operation that could result in damage or unsafe coach operations. When these conditions are detected the unit is programmed to respond automatically in a manner which is safest for the occupants, vehicle and transmission.

These control systems generally consist of several major components connected through chassis wire harness. Among these are the Electronic Control Unit (ECU), the engine Throttle Position Sensor (TPS) or Serial Communication Interface (SCI) or a more direct electronic communication as provided by an electronic accelerator pedal assembly, various speed sensors, shift selector, and an internal control module, which contains the solenoid valves and pressure switches.

The throttle position sensor, speed sensors, pressure switch, and shift selector transmit information to the ECU. The ECU in turn processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

NOTE: Throttle Position Sensors (TPS) are used with non-electronic engine installations only. Some electronically controlled Caterpillar and Cummins engine installations may have required a Vehicle Interface Module (VIM) to conform to SAE J1708 and J1587.

COMPONENTS

ELECTRONIC CONTROL UNIT

Coaches equipped with the HT-741, HT-746 HTB-748 and HT-755 ATEC model transmission installations feature the “Splashproof Standard” (sealed) or “Sealed Plus II” electronic control units (Figure 7). The ECU for both systems is mounted in the overhead ATEC/DDEC control box located in the LH #1 baggage bay.

NOTE: The ATEC/DDEC control box is located in the LH #3 baggage bay on earlier model coaches. The “Maxi-Feature” ECU is used on retarder installations only.

The control system ECU is an electronic microcomputer which receives information in the form of electronic signals from the various sensors, processes the information, and sends electronic signals to the appropriate solenoids which control the transmission operation.

The ECU on (ATEC) control systems contain an Electronically Programmable Read-Only Memory (EPROM) microchip. These EPROMS contain shift calibration for the specific transmission installations along with other constants that dictate transmission and/or retarder operations.

⚠ CAUTION ⚠

The EPROMS and EEPROMS are designed for specific combinations of drive axle ratios, transmission models and tire sizes. Any appreciable difference in the replacement of such items, may result in the need to replace the EPROM with one which is more compatible, or reconfigure the EEPROM with the newer combination of equipment. Failure to do so may result in reduced transmission performance.

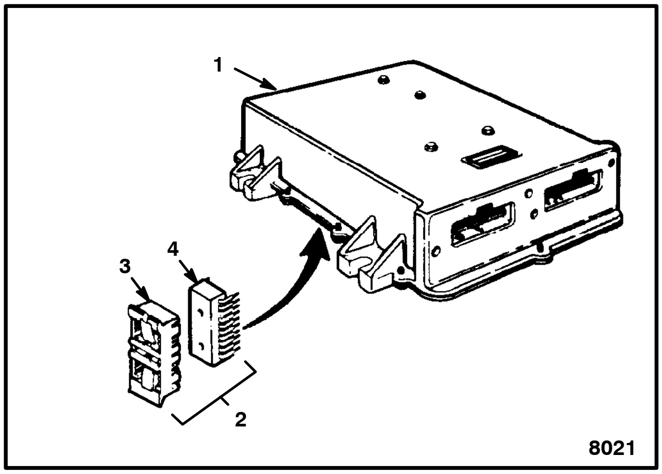


Figure 7. ECU & EPROM Assembly

This PROM/ECU assembly number is used to determine the specific encoded information of the electronic control unit for servicing or corrective action. Refer to the Allison parts manual for the correct service replacement ECU part number, or the service part number for a remanufactured ECU without PROM.

An EPROM assembly (key #2) consists of two serviceable parts which are the EPROM retainer (key #3) and the EPROM (key #4). Both parts along with an ECU makeup a complete PROM/ECU assembly (key #1) (Figure 7). This assembly part number is displayed on the identification label attached to the ECU. An electronic Diagnostic Data Reader (DDR) for ATEC transmissions can also be used to identify the correct PROM/ECU assembly part number.

NOTE: An ATEC electronic control unit can only be obtained in the incomplete form (without EPROM).

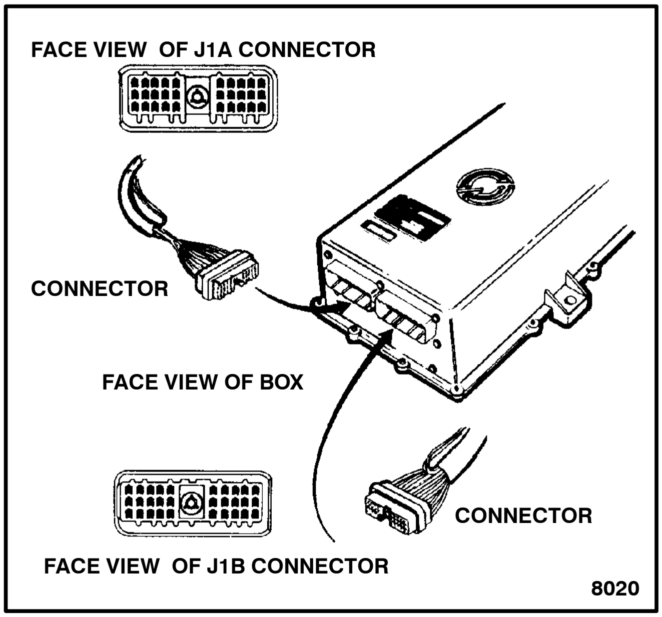


Figure 8. Electronic Control Unit

HARNESSES

The ATEC electronic control unit harnesses utilize two 30-terminal input/output connectors (Figure 8). The splash-proof connectors are held in place by a center screw attachment. An electrical connector removal tool is available from Kent-Moore P/N J35813.

MAINTENANCE

ELECTRONIC CONTROL UNIT

PROM SERVICE (ATEC)

The replacement EPROM is available only in the service PROM kit. Specific shift points for the various PROM kits are listed in Allison's *"ECU/PROM Calibration and Shift Points Data"* manual (SA 2058).

A PROM and retainer (5) service kit is also available, and consists of: PROM and retainer assembly, security label (for access cover), part number identification label and instruction sheet.

An Allison *"ECU/PROM Calibration and Shift Points Data"* manual (SA 2058) for ATEC transmissions is available through authorized Allison distributors. This manual provides service ECU and service PROM kit part numbers along with calibration and shift points data for the ATEC series transmissions. When ordering new ECU's, also order a new service PROM kit (PROM/Retainer Assembly) to be compatible with the new ECU. Select the kit that has the same calibration as the old PROM.

RESET PROCEDURES

Most of the minor or temporary transmission faults that would initiate a "Do Not Shift" tell-tale light may be cleared by using the following procedures.

On ATEC control systems to attempt reset and with the selector in (N), position the selector to (R) then back to (N) and then to (D) range once. Another common reset procedure requires that the transmission be placed in (N), shut off engine and wait about 10 seconds before restarting.

NOTE: If the condition is minor or temporary, the tell-tale will not come back on and the transmission should operate normally. If the condition is more serious, the tell-tale will again light and the transmission may remain inhibited or operate in a normal manner until the condition is detected again. However, direction changes will not occur, and the type of operation permitted by the ECM will depend on the type of problem or fault existing. In a severe fault situation the transmission could possibly remain in the neutral position during an attempted reset procedure.

ECU REMOVAL

1. Place battery disconnect switch "Off". Apply the parking brake.
2. Disconnect all electrical harnesses to and from the ECU.
3. Unfasten and remove the ECU mounting capscrews and remove the ECU from the ATEC/DDEC control box.

ECU INSTALLATION

1. Reinstall in reverse order of the "Removal" procedure.

TROUBLESHOOTING

DIAGNOSTIC CODES

If the value of any of the transmitted signals is not within the limits programmed into the ECU memory, the ECU will turn on the "CHECK TRANS" light on the tell-tale warning cluster and a diagnostic code will be logged into the memory. All codes fall into one of two categories, soft or hard. A soft code does not interfere with the operation of the vehicle. A hard code will cause the ECU to limit the operation of the transmission to protect it from damage and will also turn on the "DO NOT SHIFT" light. The diagnostic code identifies the problem circuit. A circuit consists of a component which sends or receives a signal (such as a speed sensor), the harness wiring, connectors and/or the ECU.

Two methods are used to read the diagnostic code. The most common of these is to place the transmission diagnostic test switch to "ON" which should cause the code to flash. The second method involves connecting a display dataline (DDL) reader into the harness plug provided in either the DDEC/ATEC control box, or under the driver's seat. The DDL will read the diagnostic codes from the ECU memory. One hard code and one soft code can be retained in the ECU's memory and be displayed at any time.

NOTE: The memory of the ECU will only store two diagnostic codes; however, more than two problems may exist. The first two codes should be corrected and cleared and any remaining problems, if present, will then be logged into the ECU.

When the test switch is on, the ECU will flash the diagnostic code. For example, a code 12 would consist of one flash followed by a short pause, then two flashes in quick succession. After a long pause, the code should repeat. This process continues as long as the test switch is “ON”. Only one code will be flashed out. The second code will be stored until the first code is fixed and cleared from the ECU memory. To clear a code, the test switch must first be in the “ON” position and the transmission in neutral. Next, select reverse and then re-select neutral. If a code does not clear, the problem is still present and must first be corrected before it can be cleared. Diagnostic codes should be cleared after repairs have been completed.

NOTE: After clearing, some codes may require several cycles of “Key starting”.

ELECTRICAL CHECKS

Normally, a trouble code indicates the computer has detected an improper resistance or condition in the component named by the code, or in the wiring to that component. The technician should first follow the normal procedure published in the troubleshooting manual, which checks the component and wiring for opens, short circuits between wires and short circuits to ground. The technician may use the single page schematic of the ATEC system in Appendix I of the troubleshooting manual to perform most of these checks. This will fix many of the trouble codes coaches may experience.

If after the normal troubleshooting procedures are followed and no cause for the code is found, some other potential causes for codes are as follows:

1. The ATEC system requires battery direct ground. These are ATEC Wires 208 and 209. If these wires are not battery direct, are common to other electrical equipment grounds, the connection to ground is loose, or the connection to ground is painted or dirty, intermittent codes may result.

2. The ATEC system also requires battery direct power. These are wires 202 and 223. If input power has fluctuations, or is intermittent, codes may result. Check for other 12 vdc loads off of the ECU power (i.e., radios, lights, horns, etc.).

3. Wire 201 must be grounded to the chassis. This wire is the short wire which comes out of the chassis harness connector at the ECU, and normally has a tag on it instructing the reader to ground this wire. Wire 201 is a part of the ATEC system’s protection against outside interference.

4. An area where a ground can be difficult to detect is in the end bell area of the chassis harness. If a wire has rubbed through its insulation and contacted the end bell, a short to ground exists. When the chassis harness is removed from the bulkhead connector, the short to ground is broken. To detect a short between a wire and the end bell, the volt-ohmmeter should check between the end bell and all pins in the chassis harness connector (Figure 9). The wires in this area should also be carefully inspected for damage.

5. Another area which may generate a short to ground that is intermittent and difficult to detect is a short between internal harness wires and the valve body or oil filter. The internal harness should be carefully inspected with a light to expose worn areas in the internal harness that will intermittently contact surrounding metal (Figure 9).

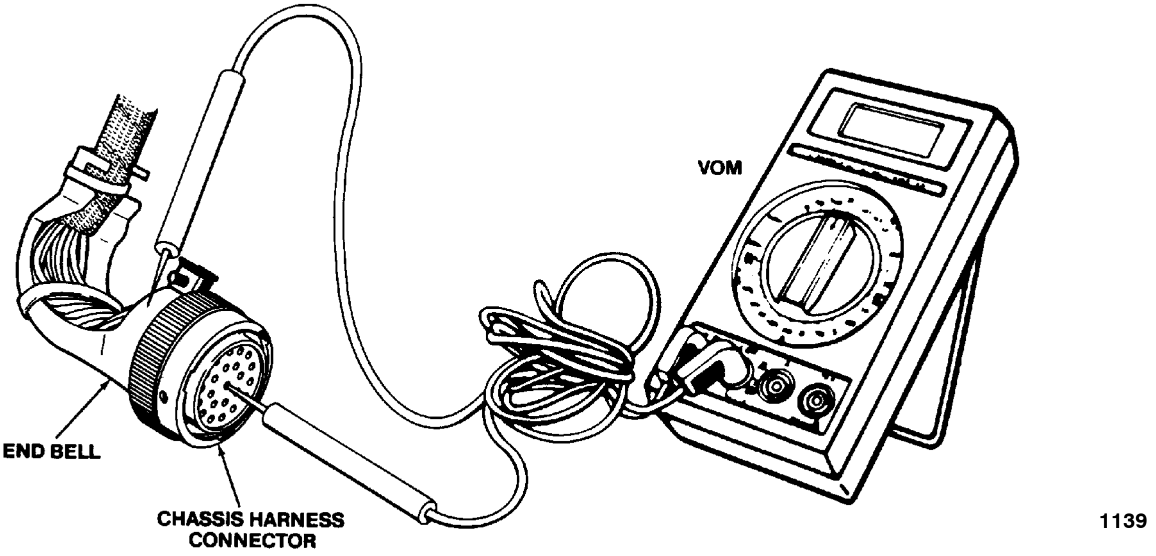


Figure 9. Harness Check

6. Corroded or dirty connections at the chassis harness connector will cause intermittent diodes.This area must only be cleaned with a contact cleaner consisting of at least 90% freon. Cleaners containing petroleum distillates will damage the connector.

7. When experiencing intermittent solenoid codes, particularly those involving the latching solenoids, bad solenoid lead wire to terminal crimps have been found in several locations. The latching solenoids are connected together in a chain, therefore, resistance problems in one solenoid circuit in the chain may affect the generation of trouble codes for other solenoids, due to the way the ECU measures the resistance of the latching solenoid chair. These crimps may be soldered or recrimped to prevent this condition from occurring. An illustration of these parts follows (Figure 12).

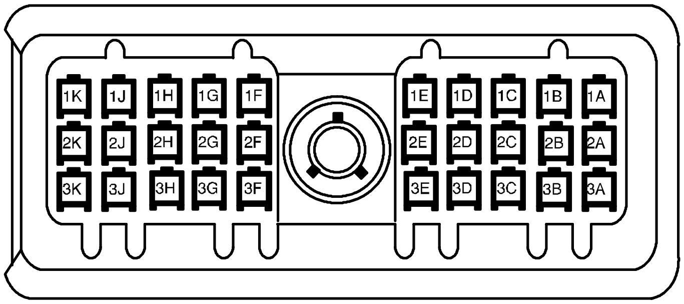
DIAGNOSTIC DATA READER

The Diagnostic Data Reader (DDR) is an optional service device available through Allison service tool sources Kent-Moore P/N J38538. The purpose of the DDR device (also known as the "ProLink 9000") is to assist in the installation check-out and troubleshooting of transmission malfunctions as detected by the ECU. The DDR may also be used to modify certain shift calibration parameters.

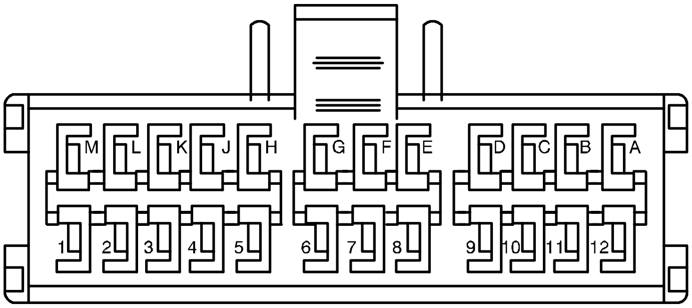
The DDR is a portable microcomputer-based receiver/transmitter/display unit. The DDR transmits and receives data to and from the ECU, processes the data and displays appropriate information to the servicer. Operating instructions are supplied with each DDR

CONNECTOR PIN CHARTS

To provide troubleshooting coverage for ATEC systems with Splashproof Standard Electronic Control Unit connectors, and earlier Sealed Plus I & II ECU's the following connector pin charts are provided. These charts will enable service technicians to perform troubleshooting on most ATEC systems using the existing splash-proof troubleshooting manuals (Figures 10 and 11).



SEALED HARNESS TO ECU J–J1A
CONNECTOR (WHITE)



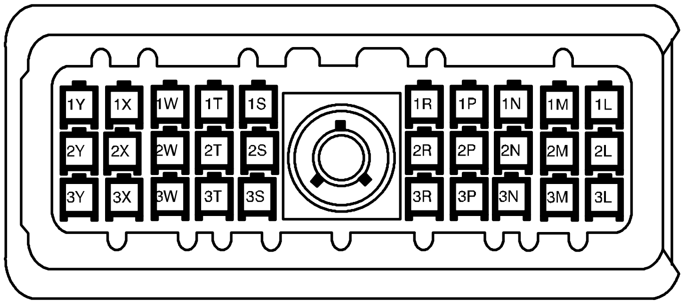
SPLASHPROOF HARNESS TO ECU J–2
CONNECTOR (BLACK)

* WIRE COLORS MAY NOT BE CONSISTANT WITH HARNESS

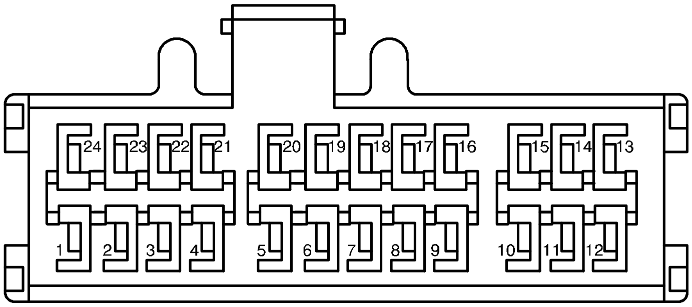
SEALED CONNECTOR J–1A	SPLASHPROOF CONNECTOR J–2	CIRCUIT NO.	WIRE COLOR*	CIRCUIT
2K	1	201	WHITE	VEHICLE CHASSIS – GROUND
2A	2	202A	RED	+ 12V POWER
3A	3	203	BLUE	CONTINOUS POWERED MEMORY (12V)
1F	4	204	WHITE	SHIFT SELECTOR
3G	5	205	GREEN	SPEEDOMETER
1G	6	206	VIOLET	SHIFT SELECTOR
1J	7	207A	BLUE	DDL/DIGITAL DISPLAY
1A	8	208	BLACK	BATTERY – GROUND
1B	9	209	BLACK	BATTERY – GROUND
2C	10	210A	BLACK	GROUND
3F	11	211	YELLOW	RETARDER – IN
3J	12	212	RED	DO NOT SHIFT
3D	A	213	BLUE	RETARDER – OUT
2D	B	214	WHITE	REVERSE
3H	C	215	VIOLET	CHECK TRANS – OUT
2J	D	216A	YELLOW	TEST SWITCH
1E	E	217	VIOLET	2 SPEED GOVERRNOR
1H	F	218	BLUE	SHIFT SELECTOR
2H	G	219	GREEN	SHIFT SELECTOR
2G	H	220	YELLOW	SHIFT SELECTOR
2F	J	221	VIOLET	SHIFT SELECTOR
1K	–	222	RED	SPL PURPOSE INPUT
2B	L	223A	RED	+ 12V POWER
3K	–	224	WHITE	SPL PURPOSE OUTPUT

8027

Figure 10. ECU J-1 (OR J-1B) Connector


1Y
1X
1W
1T
1S
1R
1P
1N
1M
1L
2Y
2X
2W
2T
2S
2R
2P
2N
2M
2L
3Y
3X
3W
3T
3S
3R
3P
3N
3M
3L

SEALED HARNESS TO ECU J−J1B CONNECTOR (WHITE)


24
23
22
21
20
19
18
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16
15
14
13
1
2
3
4
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7
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9
10
11
12

SPLASHPROOF HARNESS TO ECU J−1 CONNECTOR (BLACK)

* WIRE COLORS MAY NOT BE CONSISTANT WITH HARNESS

SEALED CONNECTOR J−1B	SPLASHPROOF CONNECTOR J−1	CIRCUIT NO.	WIRE COLOR*	CIRCUIT
2N	1	101	RED	12V
−	2	−	−	SPARE
−	3	−	−	SPARE
2P	4	104	YELLOW	THROTTLE SENSOR − PIN B
1W	5	105	VIOLET	B AND F SOLENOID
1N	6	106A	BLACK	THROTTLE SENSOR − PIN C
1Y	7	107	GREEN	LOCKUP SOLENOID G−
2M	8	108	YELLOW	NEUTRAL SOLENOID H+
2Y	9	109	BLUE	LOCKUP SOLENOID G+
1S	10	110	WHITE	C AND D SOLENOID
3M	11	111	GREEN	J SOLENOID
1L	12	112	WHITE	SPEED SENSOR HIGH − PIN B
1M	13	113	BLACK	SPEED SENSOR LOW − PIN A
3L	14	114	WHITE	J AND C SOLENOID
1T	15	115	GREEN	A AND B (5 SPEED ONLY)
1R	16	116	YELLOW	REVERSE PRESSURE SWITCH
3Y	17	117	BLACK	H AND E SOLENOID
3P	18	118	BLUE	FORWARD PRESSURE SWITCH
2W	19	119	RED	TRIM BOOST SOLENOID E+
2T	20	120	BLUE	D AND F SOLENOID
3T	21	121	RED	SOLENOID − B (4 SPD) − A (5 SPD)
3N	22	122	VIOLET	LUBE PRESSURE SWITCH
2L	23	123	VIOLET	TEMPERATURE SENSOR +
1P	24	124	RED	THROTTLE SENSOR − PIN A

8028

Figure 11. ECU J-2 (or J-1A) Connector

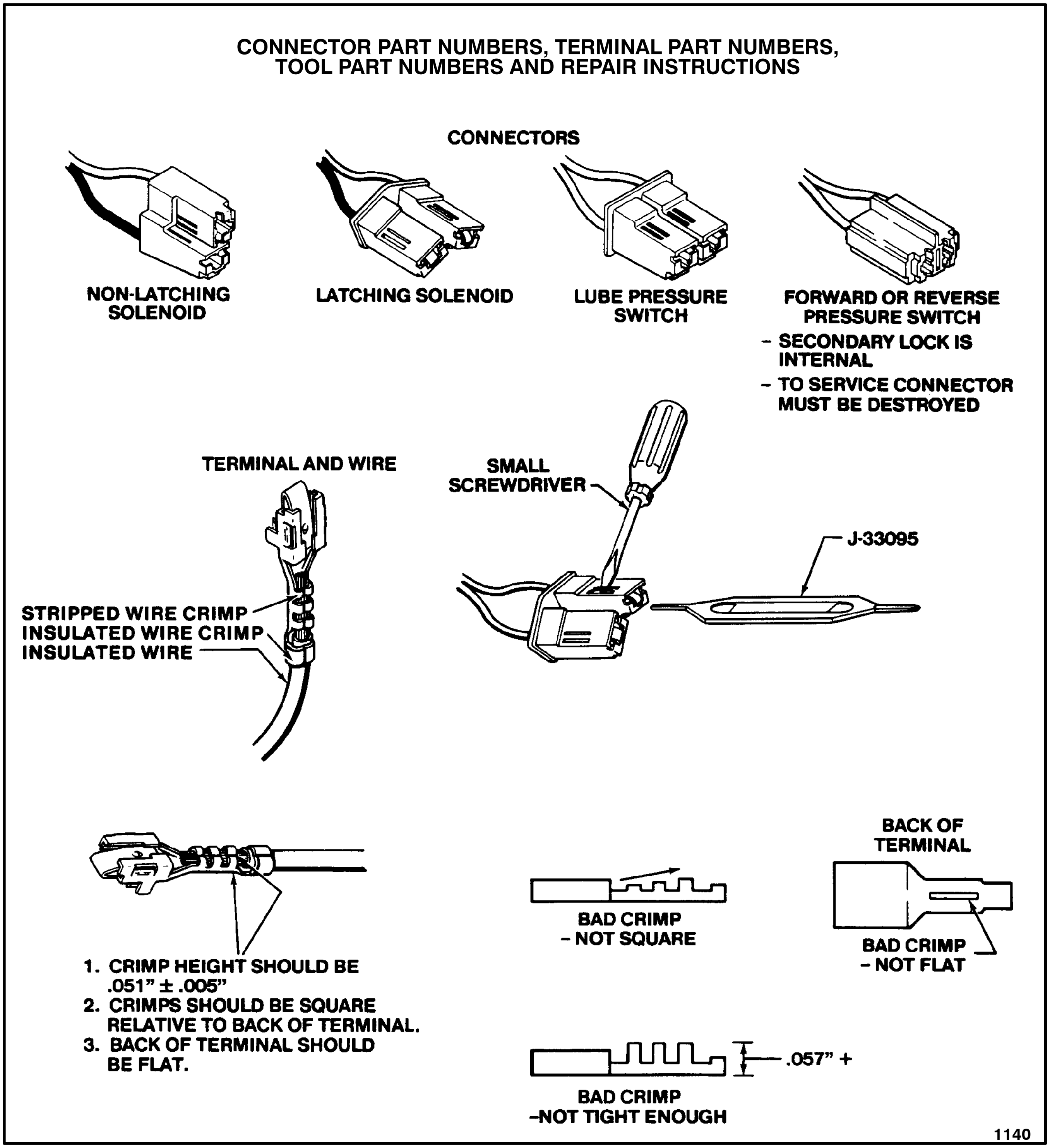

CONNECTOR PART NUMBERS, TERMINAL PART NUMBERS,
TOOL PART NUMBERS AND REPAIR INSTRUCTIONS
CONNECTORS
NON-LATCHING SOLENOID
LATCHING SOLENOID
LUBE PRESSURE SWITCH
FORWARD OR REVERSE PRESSURE SWITCH
- SECONDARY LOCK IS INTERNAL
- TO SERVICE CONNECTOR MUST BE DESTROYED
TERMINAL AND WIRE
STRIPPED WIRE CRIMP
INSULATED WIRE CRIMP
INSULATED WIRE
SMALL SCREWDRIVER
J-33095
1. CRIMP HEIGHT SHOULD BE .051" ± .005"
2. CRIMPS SHOULD BE SQUARE RELATIVE TO BACK OF TERMINAL.
3. BACK OF TERMINAL SHOULD BE FLAT.
BAD CRIMP - NOT SQUARE
BACK OF TERMINAL
BAD CRIMP - NOT FLAT
.057" +
BAD CRIMP -NOT TIGHT ENOUGH
1140

Figure 12. Connectors

TORQUE SPECIFICATIONS

Transmission Hydraulic Line Fittings	40-50 ft-lbs (53-66 N·m)
Transmission Mounting Bracket Capscrews	168-196 ft-lbs (227-265 N·m)
Transmission Flange Mounting Capscrews	40-50 ft-lbs (53-66 N·m)
Transmission Flange Mounting Capscrews (Cummins)	54-65 ft-lbs (72-86 N·m)
Flexplate-to-Converter Mounting Capscrews (1/2”-20)	95-115 ft-lbs (126-153 N·m)
Flexplate-to-Converter Mounting Capscrews (3/8”-24)	41-49 ft-lbs (54-65 N·m)

SPECIFICATIONS

TRANSMISSION ASSEMBLY - HT-740

Manufacturer	Allison
Part Number (W/495 Series Torque Converter & 6V-92)	13J-1-3
Part Number (W/Tone Ring, 495 Series Torque Converter & 6V-92)	13L-1-160
Part Number (W/496 Series Torque Converter & 8V-92)	13J-1-10
Part Number (W/496 Series Torque Converter & 8V-92)	13J-1-24
Part Number (W/Tone Ring, 496 Series Torque Converter & 8V-92)	13L-1-161
Part Number (W/497 Series Torque Converter & 6V-92)	13J-1-1
Part Number (W/Tone Ring, 497 Series Torque Converter & 6V-92)	13L-1-159
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-126
Part Number (W/Tone Ring, 496 Series Torque Converter & Series 60)	13L-1-162
Part Number (W/498 Series Torque Converter & Series 60)	13L-1-139
Part Number (W/Tone Ring, 498 Series Torque Converter & Series 60)	13L-1-163
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-147
Part Number (W/Tone Ring, 496 Series Torque Converter & Caterpillar)	13L-1-164
Part Number (W/Tone Ring, 496 Series Torque Converter & Cummins)	13L-1-172

TRANSMISSION ASSEMBLY - HT-754

Manufacturer	Allison
Part Number (W/495 Series Torque Converter & 6V-92)	13G-1-19
Part Number (W/496 Series Torque Converter & 8V-92)	13J-1-7

TRANSMISSION ASSEMBLY - HT-741

Manufacturer	Allison
Part Number (W/495 Series Torque Converter & 6V-92)	13K-1-8
Part Number (W/495 Series Torque Converter & 6V-92)	13K-1-120
Part Number (W/496 Series Torque Converter & 8V-92)	13K-1-2
Part Number (W/496 Series Torque Converter & 8V-92)	13K-1-118
Part Number (W/497 Series Torque Converter & 6V-92)	13K-1-9
Part Number (W/497 Series Torque Converter & 6V-92)	13K-1-121
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-127
Part Number (W/498 Series Torque Converter & Series 60)	13L-1-184
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-140
Part Number (W/496 Series Torque Converter & Cummins)	13L-1-177

SPECIFICATIONS (CONTD.)

TRANSMISSION ASSEMBLY - HT-746

Manufacturer	Allison
Part Number (W/495 Series Torque Converter & Caterpillar)	13L-1-467
Part Number (W/495 Series Torque Converter & Cummins)	13L-1-7
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-116
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-183
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-117
Part Number (W/496 Series Torque Converter & Cummins)	13L-1-142
Part Number (W/497 Series Torque Converter & Cummins)	13K-1-115
Part Number (W/498 Series Torque Converter & Series 50)	13G-1-35

TRANSMISSION ASSEMBLY - HTB-748

Manufacturer	Allison
Part Number (W/495 Series Torque Converter & 6V-92)	13L-1-102
Part Number (W/495 Series Torque Converter & 6V-92)	13L-1-77
Part Number (W/497 Series Torque Converter & 6V-92)	13L-1-17

TRANSMISSION ASSEMBLY - HT-755

Manufacturer	Allison
Part Number (W/495 Series Torque Converter & 6V-92)	13K-1-10
Part Number (W/495 Series Torque Converter & 6V-92)	13K-1-122
Part Number (W/496 Series Torque Converter & 8V-92)	13K-1-5
Part Number (W/496 Series Torque Converter & 8V-92)	13K-1-119
Part Number (W/497 Series Torque Converter & 6V-92)	13L-1-11
Part Number (W/497 Series Torque Converter & 6V-92)	13K-1-123
Part Number (W/496 Series Torque Converter & Series 60)	13L-1-128
Part Number (W/498 Series Torque Converter & Series 60)	13L-1-185
Part Number (W/496 Series Torque Converter & Caterpillar)	13L-1-173
Part Number (W/496 Series Torque Converter & Cummins)	13L-1-178

COOLER ASSEMBLY

Manufacturer	Allison
Part Number (Series 60 Installations)	6L-8-528
Part Number (Series 60 Installations) (Accessible Lavatory)	6L-8-730
Part Number (Cummins & Caterpillar Installations)	6K-8-48
Part Number (6V-92 Installations) (Rebuildable)	8K-15-1

FILTER ASSEMBLY

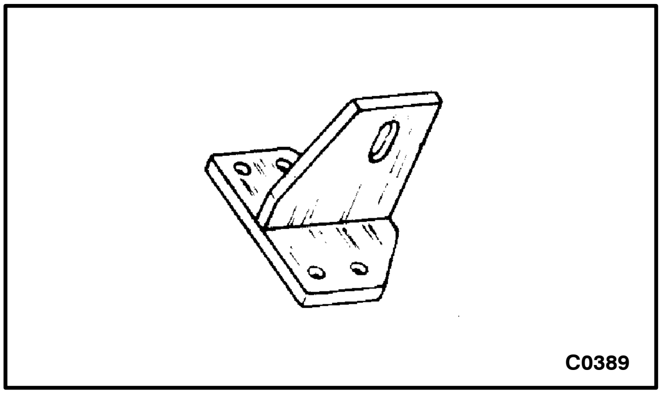
Manufacturer	A.C. Delco
Part Number	13G-10-24
Part Number (Element)	13G-10-26

CAPACITY SCHEDULE

HT-740D HT-754	Initial Factory Fill: 44 Qts. (41.5 L) Initial Factory Fill: 44 Qts. (41.5 L) *Note: Capacities are approximate only. Please check dipstick levels with the proper "Fluid Level Check" procedure.*	Service Fill: 37 Qts. (35 L) Service Fill: 37 Qts. (35 L) *Note: Capacities shown are for 4-1/2" deep oil pan.*
HT-741 HT-746 HTB-748 HT-755	Initial Factory Fill: 44 Qts. (41.5 L) Initial Factory Fill: 44 Qts. (41.5 L) Initial Factory Fill: 50 Qts. (44.5 L) Initial Factory Fill: 44 Qts. (41.5 L) *Note: Capacities are approximate only. Please check dipstick levels with the proper "Fluid Level Check" procedure.*	Service Fill: 34 Qts. (32. L) Service Fill: 34 Qts. (32. L) Service Fill: 34 Qts. (32 L) Service Fill: 34 Qts. (32 L) *Note: Capacities shown are for 4-1/2" deep oil pans.*

SERVICE TOOLS

SOME OF THE TOOLS USED FOR THE MAINTENANCE PROCEDURES OUTLINED IT THIS SECTION ARE NONSTANDARD. THEY ARE, HOWEVER, AVAILABLE FOR PURCHASE FROM MOTOR COACH INDUSTRIES AND UNIVERSAL COACH PARTS. WHERE PRACTICAL, THEY MAY BE FABRICATED BY THE SERVICE FACILITY.



Lifting Lug - P/N 20-57

SECTION 13

ALLISON (B-500/R & HD-4060/R) AUTOMATIC TRANSMISSION

SECTION 13

AUTOMATIC TRANSMISSION (B-500, B-500R, HT-4060 & HT-4060R)

CONTENTS OF THIS SECTION

SUBJECT PAGE

Transmission Assembly 13-1
- General Description 13-1
- Components 13-1
- Maintenance 13-3

Electronic Control System 13-6
- General Description 13-6
- Components 13-6
- Maintenance 13-7
- Troubleshooting 13-8

Miscellaneous Torque Specifications 13-10

Specifications 13-11

Capacity Schedule 13-11

TRANSMISSION ASSEMBLY

GENERAL DESCRIPTION

Some coaches may be equipped with the Allison (WTEC) B-500 or B-500R “World” six-speed close-ratio, heavy duty, electronically controlled transmissions. Some conversion coaches are equipped with the Allison (WTEC) HD-4060 or HD-4060R transmissions. These transmission installations typically feature a lockup torque converter assembly with torsion dampening, triple planetary gear setup, remote mounted oil cooler assembly and the (WTEC version 6), (WTEC II version 7), or (WTEC III version 8) electronic control system.

Other unique features of the B-500 and HD-4060 series transmissions are internal filtration systems and combination control module and sump cover assemblies. Coaches equipped with the B-500R and HT-4060 transmissions additionally incorporate an output retarder assembly and an accumulator circuit.

Detailed service procedures for the Allison B-500, B-500R, HT-4060 and HT-4060R (WTEC) automatic transmissions may be found in the applicable Allison Transmission Service Manuals.

NOTE: The HT-4060 series (WTEC) transmissions are designed for lighter duty operational cycles.

COMPONENTS

ELECTRONIC CONTROL SYSTEM

The (WTEC) Electronic Control System consists of six major components connected by wiring harness. These components are the Electronic Control Unit (ECU), Vehicle Interface Module (VIM) both located in the #1 baggage compartment, an electronic accelerator pedal, three speed sensors, shift selector, and control valve module (which contain the solenoid valves and pressure switch).

The throttle position sensor, speed sensors, pressure switch, and shift selector transmit information to the ECU. The ECU processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

A feature of the WTEC control system has the ability to adapt or “learn” as it operates. Each shift is electronically measured, stored, and used by the ECU to adapt to the optimum conditions for future clutch application and release.

TORQUE CONVERTER

The torque converter consists of three elements which are the pump, turbine and stator assemblies. The pump is the input element and is driven directly from the engine. The turbine is the output element and is hydraulically driven by the pump.

The stator is a reaction (torque multiplying) element. When the pump turns faster than the turbine, the converter is multiplying torque. When the turbine approaches the speed of the pump, the stator starts to rotate with the pump and turbine. when this occurs, torque multiplication stops and the converter functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of three elements which are the piston, clutch plate/damper and a back plate. the piston and back plate are driven by the engine. The clutch plate/damper, located between the piston and the back plate, is splined to the converter turbine. The lockup clutch is engaged and released in response to electronic commands from the ECU. Engagement of the lockup clutch provides a direct drive from the engine to the transmission gearing. This eliminates converter slippage to provide maximum fuel economy. The torsional dampening feature absorbs engine vibration.

PLANETARY GEARS & CLUTCHES

A series of three planetary gear sets and shafts provide the gear ratios and direction of travel for the coach. The planetary gear sets are controlled by five multi-plate clutches that work in pairs to produce the four speeds. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate combination of clutch solenoids.

RETARDER

The self-contained retarder assembly of the B-500R and HT-4060R transmissions are located at the rear output area and consists of a vaned rotor which rotates in a vaned cavity. When the retarder is applied, a control valve instantly releases fluid to fill the retarder cavity. The rotating element acts to quickly slow the coach.

COOLER CIRCUIT

The transmission fluid is cooled by a remote-mounted fluid cooler. Connections for this cooling circuit are located at the rear of the transmission to facilitate installation of remote cooler lines.

Additionally, all B-500R retarder transmissions are equipped with a separate accumulator assembly that releases fluid used by the retarder while in operation, and as a storage reservoir for the fluid while retarder is not in use.

SHIFT SELECTOR

The electronically controlled hydraulic auto-shifting of the B-500 and B-500R five-speed WT transmissions are totally automatic. The shift range selections are made through either touch-pad modules or T-handled shift selector controls located on the floor console to the right of driver or on the lower LH console (Figure 1 & 2).

NOTE: Effective with unit #50577 the shift selector module was changed to reflect the differences between (WTEC II) version 7 and (WTEC III) version 8.

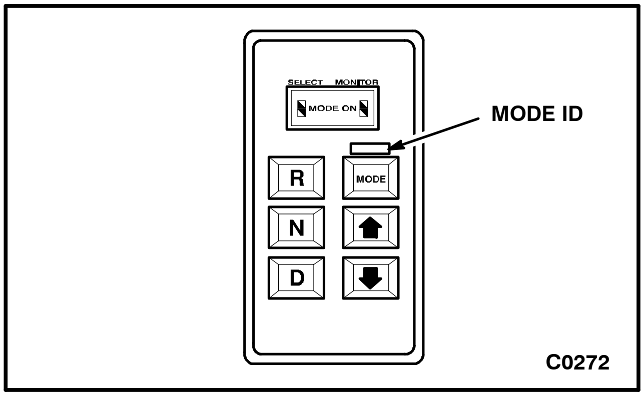


Figure 1. Shift Selector

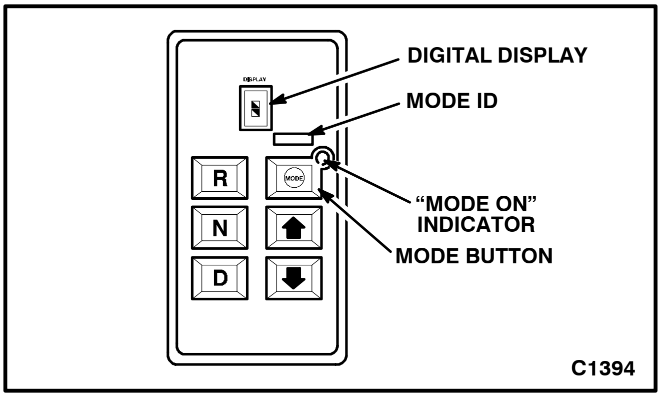


FIGURE 2.

NOTE: The transmission incorporates a hold feature to prohibit upshifting above the range selected during normal driving. For downhill operation, however, the transmission may upshift above the highest selected range when engine governed speed is exceeded and damaging engine over-speed is a possibility.

MAINTENANCE

PERIODIC INSPECTIONS

Clean and inspect the exterior of the transmission at regular intervals. Severity of the service conditions will determine the frequency of these inspections. Some of the more common inspections would focus on the following conditions:

A. Loose fasteners on the transmission and mounting components.

B. Improper fluid levels or fluid leaks.

C. Damaged or loose cooler hoses.

D. Worn or improperly routed electrical harnesses.

E. Loose, dirty, or improperly adjusted electronic throttle sensor.

LUBRICATION

The transmission fluid cools, lubricates and transmits hydraulic power. Always maintain proper fluid levels. If fluid level is too low, the torque converter and clutches do not receive an adequate supply of fluid and the transmission overheats. If the level is too high, the fluid aerates causing the transmission to shift erratically and overheat. Fluid may be expelled through the breather or dipstick tube when fluid level is too high.

Transmission fluid level should be checked daily with the manual cold check procedure. Transmission hot fluid level can be checked manually or electronically. Check the fluid level using the following procedures and record in a maintenance log.

⚠ WARNING ⚠

When checking the fluid level by the manual method, be sure the transmission is in neutral, the park brake is applied and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

FLUID LEVEL CHECK

Manual Cold

The purpose of the cold check is to determine if the transmission has enough fluid to be operated safely until a hot check can be made. Always check the fluid level reading with the engine running and at least twice.

1. Park vehicle on a level surface.

2. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.

3. Run the engine for at least one minute. apply the service brakes, shift transmission to drive (D) and operate engine at 1000 to 1500 rpm for 30 seconds; then shift to reverse (R) to clear the hydraulic system of air. Finally, shift into neutral (N) and allow the engine to idle (500-800 rpm).

4. With engine still running, remove the dipstick from the tube and wipe clean.

5. Insert the dipstick into tube and remove. Check the level reading.

6. Repeat the check to verify the reading.

7. If the fluid level is within the “COLD RUN” band on the dipstick, the transmission may be operated until the fluid is hot enough to perform a “HOT RUN” check. If the fluid level is not within the limits of the band, add as necessary to bring to the middle of the band.

8. Perform a hot check at the first opportunity after the normal operating temperature is reached.

Manual Hot

1. Operate the transmission in drive (D) range until normal operating temperature is reached.

NOTE: Normal operating sump temperature is in the 160-200°F (71-93°C) range. Normal operating converter-out temperature should be in the 180-220°F (82-104°C) range.

2. Park vehicle on a level surface, and allow engine to idle (500-800 rpm).

3. Clean all dirt from around the end of the fluid fill tube before removing the dipstick.

4. Insert the dipstick into tube and remove. Check the level reading.

5. Repeat the check to verify the reading.

6. If the fluid level is not within the limits of the “HOT RUN” band, add as necessary to bring to the middle of the band.

NOTE: Do not allow dirt or foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of internal components.

NOTE: Consistency is important to maintaining accuracy of the reading in a manually checked level. If inconsistent readings persist, check the transmission breather to be sure it is clean and unclogged.

ELECTRONIC FLUID CHECK

1. After reaching the normal operating temperature, park vehicle on a level surface and allow engine to idle (500-800 rpm).

2. On pushbutton shift selectors, simultaneously press the ▲ "UP" and ▼ "DOWN" arrow buttons once. On lever shift selectors, press the "DISPLAY MODE" button once.

NOTE: The oil level sensor's temperature range is from 140-220°F (60-104°C).

The ECU may delay the fluid level check until the following conditions are met:

A. Transmission fluid temperature is above 140°F or below 220°F.

B. The transmission is in neutral (N).

C. The vehicle has been stationary for five minutes to allow the fluid to settle.

D. The engine is at idle speed.

The delayed fluid level display signal is a flashing indicator under the SELECT display and a countdown from 8 to 1 under the MONITOR display.

3. A correct fluid level is reported when an "OL" is displayed ("OL" indicates the Oil Level Check Mode), followed by "OK". The "OK" display indicates that the fluid level is within an acceptable zone.

Example: "OL OK" indicates correct fluid level.

NOTE: The dipstick check may not agree exactly with sensor checks, because the oil level sensor compensates for fluid temperatures.

4. Low fluid level is reported when an "OL" is displayed, followed by "LO" and a number. "LO" indicates a low fluid level, and the number indicates quarts of fluid the transmission requires.

Example: "OL LO 02" indicates that two additional quarts of fluid should bring the level to the acceptable zone.

NOTE: Confirm an electronically obtained low fluid condition by making a manual fluid level check.

5. High fluid level is reported when an "OL" is displayed, followed by "HI" and a number. "HI" indicates a high fluid level, and the number indicates quarts overfilled.

Example: "OL HI 01" indicates one quart past the full level.

⚠ CAUTION ⚠

A low or high fluid level causes overheating and irregular shift patterns. If not corrected, this condition can damage the transmission.

6. Invalid Display conditions are reported when an "OL" is displayed, followed by "--" and a number. The displayed number is a code, and would indicate an improper condition for electronic check or a system malfunction.

Example: "OL -- 70" would indicate that the oil sump temperature is too low.

NOTE: The Invalid Display is activated when conditions do not allow the fluid level to be checked. Review the following codes and their associated conditions to assist in quickly correcting the condition.

CODES	DESCRIPTIONS
"OL -- 50"	- Engine speed (rpm) too low.
"OL -- 59"	- Engine speed (rpm) too high.
"OL -- 65"	- Neutral (N) must be selected.
"OL -- 70"	- Sump oil temperature too low.
"OL -- 79"	- Sump oil temperature too high.
"OL -- 89"	- Output shaft rotation.
"OL -- 95"	- Sensor failure.

7. To exit the oil level display mode with pushbutton shift selector, press any other button on selector. To exit the oil level display mode with lever shift selector, press the DISPLAY MODE pushbutton one time.

SPECIFICATION

Hydraulic fluids used in the B-500 and B-500R transmissions are important influences on transmission performance, reliability and durability. All lube oil fluids must qualify to Allison's Type C-4 specification, if not specifically designated as torque fluids like DEXRON IIE and/or DEXRON III. DEXRON IIE and/or DEXRON III fluids are recommended for most coach automatic transmission service conditions.

The minimum safe operating temperature of DEXRON IIE and/or DEXRON III fluids is -17°F. Sump fluid temperatures below this minimum must be preheated by running equipment with transmission in neutral for approximately 20 minutes before shifting into range operation.

⚠ CAUTION ⚠

Prevent foreign material from entering the transmission by using clean containers, fillers,

etc. and by keeping dipstick clean. Containers or fillers that have been used for antifreeze solution or engine coolant must never be used for transmission fluids.

NOTE: Antifreeze and engine coolants contain ethylene glycol. When introduced into transmissions, even small amounts of ethylene glycol can cause clutch plates to fail.

INITIAL SERVICE INTERVAL

The initial factory fill should be drained and the filters changed after the first 5,000 miles (8,000 km). Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

PERIODIC SERVICE INTERVAL

Drain and change the filters every 25,000 miles (40,000 km) or 18 months, whichever occurs first. Use lubrication specification S-15 (Automatic Transmission Fluid - DEXRON IIE and/or DEXRON III) as shown in Section 10 of this manual.

The B-500 and B-500R WT transmissions incorporate twin internal (sump mounted) filters. The filter assemblies are removed from the bottom (Figure 3).

FILTER REPLACEMENT

1. Turn Master Switch off, and block front and rear wheels.

2. Remove the drain plug from the control valve module sump and allow the fluid to drain completely.

NOTE: It is not necessary to drain the fluid if only the filters are to be replaced. The control module and sump are in assembly with each other.

3. Unfasten and remove the twelve capscrews from both filter covers.

4. Remove the cover, O-ring, gasket and filter element from the bottom of the control module.

5. Pre-lube and install an O-ring on each filter element assembly.

6. Install the gasket seal on each cover, then join filter elements onto cover assemblies.

7. Install filter and cover assemblies into the filter compartments of the control module. Align each filter/cover assembly with the holes in the channel plate/sump. Push the cover assemblies in by hand to seat the seals.

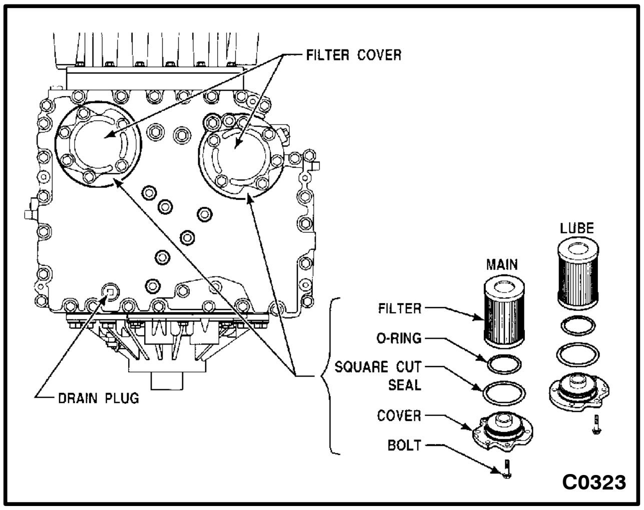


Figure 3. Internal Filters

⚠ CAUTION ⚠

Do not use the bolts to draw filter covers to the sump. This can damage the covers, seals and/or sump.

8. Install capscrews into each cover and tighten to 38-45 ft-lbs (51-61 N·m).

9. Inspect drain plug O-ring and reinstall into control module sump. Tighten plug to 18-24 ft-lbs (25-32 N·m).

10. Refill the transmission and check the fluid level using the manual fluid check procedures.

NOTE: The amount of refill fluid will be less than the amount used for the initial factory fill. Fluid should remain in the external cooler circuits, torque converter and transmission cavities after draining. Refer to the capacity schedule in specifications portion of this section for exact fluid quantities used in the B-500 and B-500R transmissions.

REMOVAL

NOTE: Use of a suitable sling, transmission jack or dolly is recommended during step 8 of this removal procedure. A transmission dolly is available through parts outlets or may be fabricated. See “Service Tools” at end of this section.

1. Place battery disconnect switch “Off”. Apply the parking brake and block vehicle wheels.

2. Drain the fluid from the transmission, and remove the dipstick and fill tube.

3. Disconnect all electrical harnesses and retarder air lines from the transmission.

4. Disconnect and remove the remote cooler, retarder accumulator and oil filter assemblies with their associated mounting brackets, lube and coolant lines from the transmission.

5. Disconnect the driveshaft from the transmission. Refer to the “Driveshaft Removal” procedure in section 14.

6. Remove the engine and transmission module as an assembly. Refer to the “Engine Removal” procedure shown in section 8A1 thru 8A4.

7. Support the rear of the engine with jack stands, and unfasten and remove the mounts and brackets attaching the transmission to the engine cradle.

8. Remove the mounting capscrews attaching the transmission to the engine flywheel housing and slide transmission out and away from engine while maintaining alignment.

⚠ CAUTION ⚠

Proper engine-to-transmission alignment must be maintained while removing transmission to prevent torque converter and input shaft binding. Do not allow the rear of the transmission to drop down and hang unsupported in the splined hubs of the torque converter. Failure to observe this caution will result in damage to the transmission and/or torque converter.

NOTE: Inspect the engine-to-transmission mounting surfaces and flex plates for any signs of wear or damage.

INSTALLATION

1. Install the transmission in reverse order of the “Removal” procedure.

ELECTRONIC CONTROL SYSTEM

GENERAL DESCRIPTION

The Allison automatic transmissions installed on coaches utilize Allison (WTEC) World Transmission Electronic Control electronic control systems. The electronic control system governs the upshift, downshift, lock-up and fault lock-in functions of transmission operation, including operations in less than nominal operating conditions.

NOTE: The control system monitors itself for fault conditions and/or operation that could result in damage or unsafe coach operations. When these conditions are detected the unit is programmed to respond automatically in a manner which is safest for the occupants, vehicle and transmission.

These control systems generally consist of several major components connected through chassis wire harness. Among these are the Electronic Control Unit (ECU), the Vehicle Interface Module (VIM), electronic accelerator pedal assembly, various speed sensors, shift selector, and an internal control module, which contains the solenoid valves and pressure switches.

The throttle position sensor, speed sensors, pressure switch, and shift selector transmit information to the ECU. The ECU in turn processes this information and sends signals to actuate specific solenoids located on the control module of the transmission. These solenoids control both the application and release of hydraulic clutch pressures during a shift function.

COMPONENTS

ELECTRONIC CONTROL UNIT

Coaches equipped with the HT-741, HT-746 HTB-748 and HT-755 ATEC model transmission installations feature the “Splashproof Standard” (sealed) or “Sealed Plus II” electronic control units (Figure 4). The ECU for both systems is mounted in the overhead ATEC/DDEC control box located in the LH #1 baggage bay.

NOTE: The ATEC/DDEC control box is located in the LH #3 baggage bay on earlier model coaches. The “Maxi-Feature” ECU is used on retarder installations only.

The control system ECU is an electronic microcomputer which receives information in the form of electronic signals from the various sensors, processes the information, and sends electronic signals to the appropriate solenoids which control the transmission operation.

The WT control system ECU has the unique ability to adapt or “learn” as it operates. Each shift is electronically measured, stored, and used by the ECU to adapt to the optimum conditions for future clutch application and release.

NOTE: It is important to note, that if the shift quality of a low-mileage coach or coach with a new or recalibrated ECU is unacceptable, simply drive the coach through its normal shift ranges a few times. After a short learning period, any rough shifting should be corrected and shift quality restored.

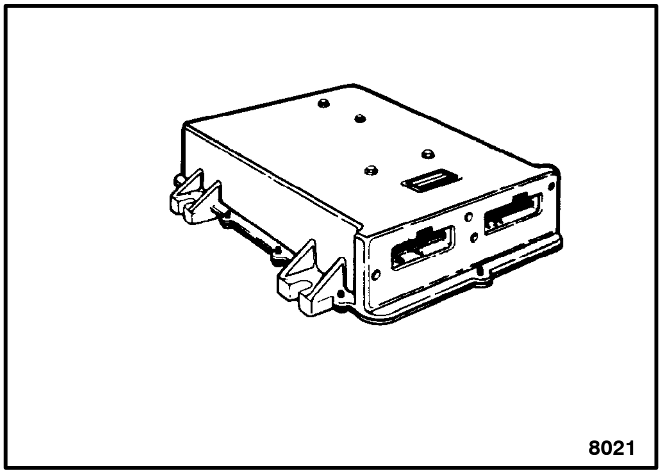


Figure 4. ECU Assembly

The ECU on (WTEC) control systems contain an Electronically Erasable Programmable Read-Only Memory (EEPROM) microchip. These EPROMS EEPROMS contain shift calibration for the specific transmission installations along with other constants that dictate transmission and/or retarder operations.

CAUTION

The EEPROMS are designed for specific combinations of drive axle ratios, transmission models and tire sizes. Any appreciable difference in the replacement of such items, may result in the need to replace the ECU, or reconfigure the EEPROM with the newer combination of equipment. Failure to do so may result in reduced transmission performance.

NOTE: The WTEC electronic control units do not have serviceable PROM assemblies. Proms parameters may be reprogrammed only at specific Allison service center locations.

This ECU assembly number is used to determine the specific encoded information of the electronic control unit for servicing or corrective action. Refer to the Allison parts manual for the correct service replacement ECU part number, or the service part number for a remanufactured ECU.

HARNESSES

The WTEC electronic control unit is interconnected to the Vehicle Interface Module (VIM) by harness. This harness utilizes one Packard 18-pin ECU output connector, and one Packard 30-pin coach components output connector. This splash-proof connector is held in place by a center screw attachment. The ECU input/output harness connectors are twin Thomas & Betts 34-pin connectors. These connectors are held in place by snap clip attachments (Figure 5).

NOTE: WTECT electronic control system block change revision from version 6 to version 7, which occurred with unit #46704, entailed harness connectors and enhanced ECU parameters.

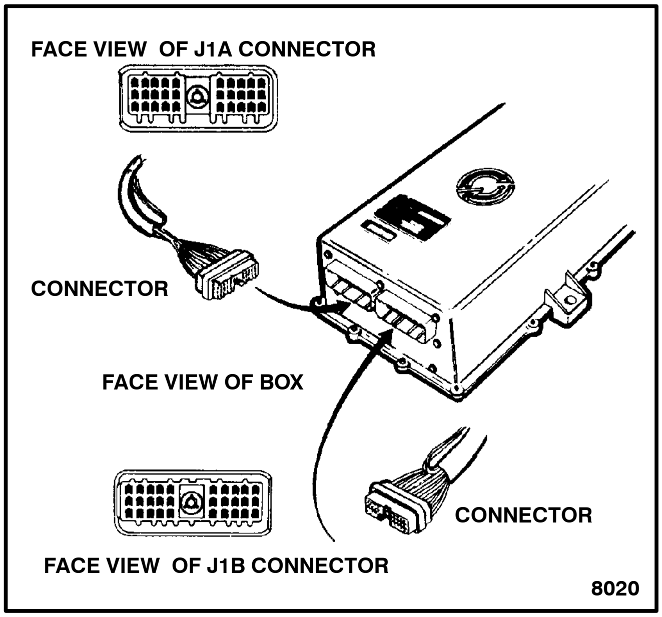


Figure 5. Harness Connections

MAINTENANCE

ELECTRONIC CONTROL UNIT

RESET PROCEDURES

Most of the minor or temporary transmission faults that would initiate a “Do Not Shift” or “Check Trans” tell-tale light may be cleared by using the following procedures.

On WTEC control systems to attempt reset and with the selector in (N), simultaneously press the “Up” and “Down” (symboled) arrow buttons twice. Press and hold the “Mode” button until a tone is heard, release button and return to normal operation. Another common reset procedure requires that the transmission be placed in (N), shut off engine and wait about 10 seconds before restarting.

NOTE: If the condition is minor or temporary, the tell-tale will not come back on and the transmission should operate normally. If the condition is more serious, the tell-tale will again light and the transmission may remain inhibited or operate in a normal manner until the condition is detected again. However, direction changes will not occur, and the type of operation permitted by the ECM will depend on the type of problem or fault existing. In a severe fault situation the transmission could possibly remain in the neutral position during an attempted reset procedure.

ECU REPLACEMENT

1. Place battery disconnect switch "Off". Apply the parking brake.

2. Disconnect all electrical harnesses to and from the ECU.

3. Unfasten and remove the ECU mounting capscrews and remove the ECU from the WTEC control box or the ATEC/DDEC junction box on MC-12 models.

4. Reinstall in reverse order of the "Removal" procedure.

TROUBLESHOOTING

DIAGNOSTIC CODES

If the value of any of the transmitted signals is not within the limits programmed into the ECU memory, the ECU will turn on the "DO NOT SHIFT" or "CHECK TRANS" lamp adjacent to shift selector or in the LH tell-tale warning cluster and a diagnostic code will be logged into the memory. A potentially damaging code will cause the ECU to limit the operation of the transmission to protect it. The diagnostic code identifies this problem circuit for correction. A circuit consists of a component which sends or receives a signal (such as a speed sensor), the harness wiring, connectors and/or the ECU.

Two methods are used to read the diagnostic code. The most common of these is to place the transmission diagnostic test switch to "ON" which should cause the code to flash. The second method involves connecting a display dataline (DDL) reader into the harness plug provided under the driver's seat or dash. The DDL will read the diagnostic codes from the ECU memory. Several codes can be retained in the ECU's memory and be displayed at any time.

NOTE: The memory of the ECU will only store two diagnostic codes; however, more than two problems may exist. The first two codes should be corrected and cleared and any remaining problems, if present, will then be logged into the ECU.

When the test switch is on, the ECU will flash the diagnostic code. For example, a code 12 would consist of one flash followed by a short pause, then two flashes in quick succession. After a long pause, the code should repeat. This process continues as long as the test switch is "ON". Only one code will be flashed out. The second code will be stored until the first code is fixed and cleared from the ECU memory. To clear a code, the test switch must first be in the "ON" position and the transmission in neutral. Next, select reverse and then re-select neutral. If a code does not clear, the problem is still present and must first be corrected before it can be cleared. Diagnostic codes should be cleared after repairs have been completed.

NOTE: After clearing, some codes may require several cycles of "Keystarting".

ELECTRICAL CHECKS

Normally, a trouble code indicates the computer has detected an improper resistance or condition in the component named by the code, or in the wiring to that component. The technician should first follow the normal procedure published in the troubleshooting manual, which checks the component and wiring for opens, short circuits between wires and short circuits to ground. The technician may use the single page schematic of the WTEC system in Appendix I of the troubleshooting manual to perform most of these checks. This will fix many of the trouble codes coaches may experience.

If after the normal troubleshooting procedures are followed and no cause for the code is found, some other potential causes for codes are as follows:

1. The WTEC system requires battery direct ground. These are WTEC Wires 143A and 143C. If these wires are not battery direct, are common to other electrical equipment grounds, the connection to ground is loose, or the connection to ground is painted or dirty, intermittent codes may result.

2. The WTEC system also requires battery direct power. These are wires 136A and 136C. If input power has fluctuations, or is intermittent, codes may result. Check for other 12 vdc loads off of the ECU power (i.e., radios, lights, horns, etc.).

3. Wire 150 must be grounded to the chassis. This wire is the short wire which comes out of the chassis harness connector at the ECU, and normally has a tag on it instructing the reader to ground this wire. Wire 150 is a part of the WTEC system's protection against outside interference.

4. An area where a ground can be difficult to detect is in the end bell area of the chassis harness. If a wire has

rubbed through its insulation and contacted the end bell, a short to ground exists. When the chassis harness is removed from the bulkhead connector, the short to ground is broken. To detect a short between a wire and the end bell, the volt-ohmmeter should check between the end bell and all pins in the chassis harness connector (Figure 6). The wires in this area should also be carefully inspected for damage.

5. Another area which may generate a short to ground that is intermittent and difficult to detect is a short between internal harness wires and the valve body or oil filter. The internal harness should be carefully inspected with a light to expose worn areas in the internal harness that will intermittently contact surrounding metal.

6. Corroded or dirty connections at the chassis harness connector will cause intermittent diodes.This area must only be cleaned with a contact cleaner consisting of at least 90% freon. Cleaners containing petroleum distillates will damage the connector.

7. When experiencing intermittent solenoid codes, particularly those involving the latching solenoids, bad solenoid lead wire to terminal crimps have been found in several locations. The latching solenoids are connected together in a chain, therefore, resistance problems in one solenoid circuit in the chain may affect the generation of trouble codes for other solenoids, due to the way the ECU measures the resistance of the latching solenoid chair. These crimps may be soldered or recrimped to prevent this condition from occurring. An illustration of these parts follows (Figure 7).

DIAGNOSTIC DATA READER

The Diagnostic Data Reader (DDR) is an optional service device available through Allison service tool sources Kent-Moore P/N J38538. The purpose of the DDR device (also known as the “ProLink 9000”) is to assist in the installation check-out and troubleshooting of transmission malfunctions as detected by the ECU. The DDR may also be used to modify certain shift calibration parameters.

The DDR is a portable microcomputer-based receiver/transmitter/display unit. The DDR transmits and receives data to and from the ECU, processes the data and displays appropriate information to the servicer. Operating instructions are supplied with each DDR.

NOTE: Connector pin information for WTEC electronic control harnesses are not shown.

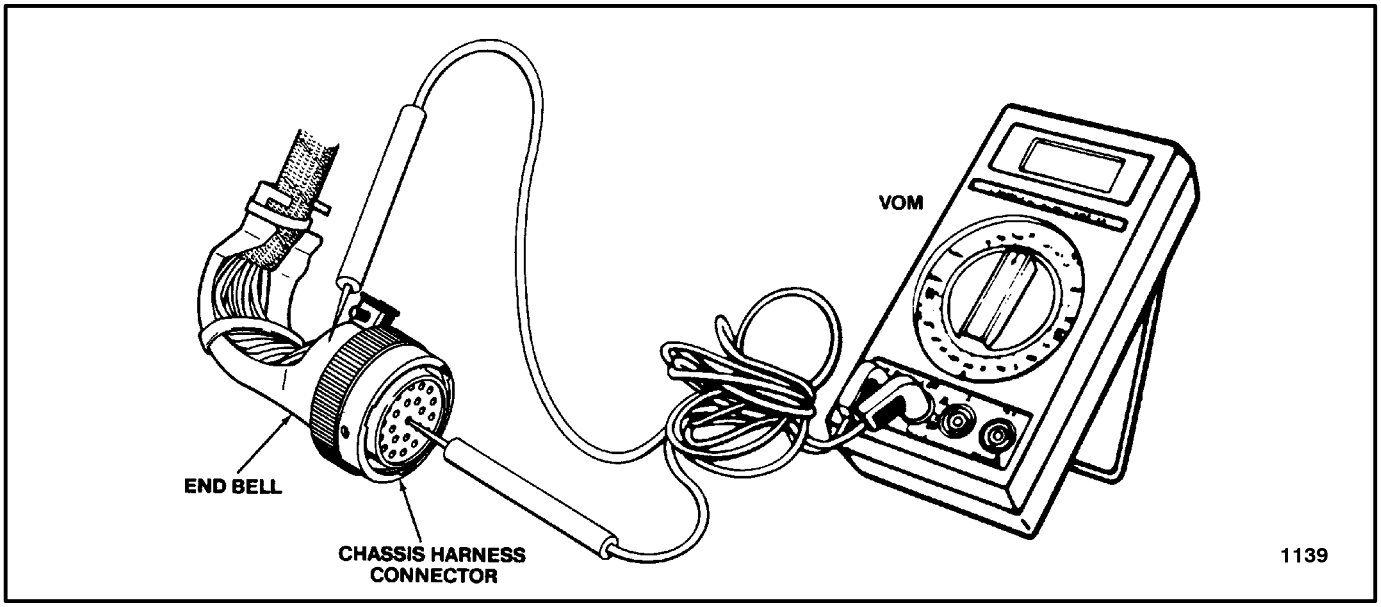


Figure 6. Harness Check

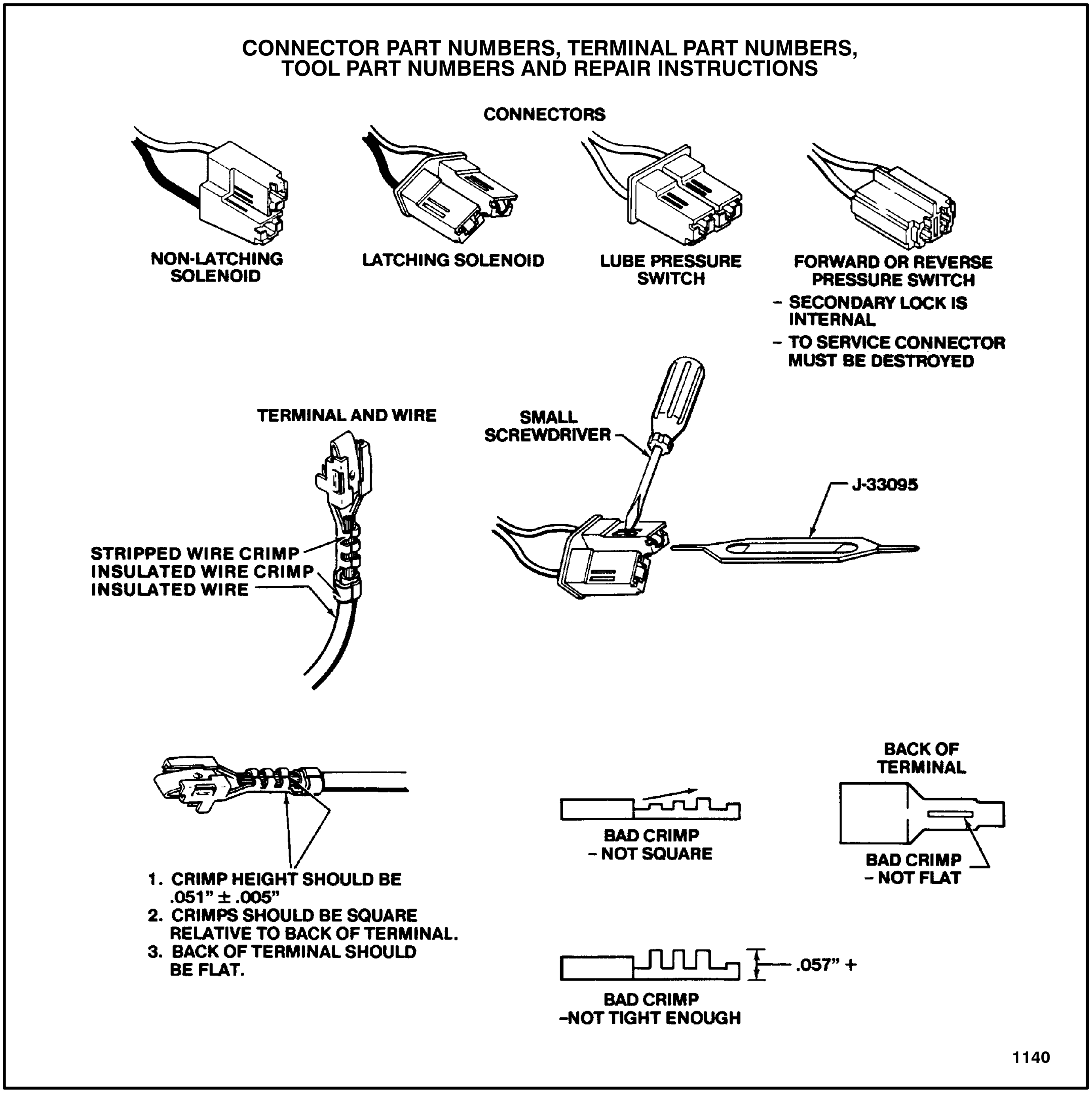

CONNECTOR PART NUMBERS, TERMINAL PART NUMBERS, TOOL PART NUMBERS AND REPAIR INSTRUCTIONS
CONNECTORS
NON-LATCHING SOLENOID
LATCHING SOLENOID
LUBE PRESSURE SWITCH
FORWARD OR REVERSE PRESSURE SWITCH
- SECONDARY LOCK IS INTERNAL
- TO SERVICE CONNECTOR MUST BE DESTROYED
TERMINAL AND WIRE
STRIPPED WIRE CRIMP
INSULATED WIRE CRIMP
INSULATED WIRE
SMALL SCREWDRIVER
J-33095
1. CRIMP HEIGHT SHOULD BE .051" ± .005"
2. CRIMPS SHOULD BE SQUARE RELATIVE TO BACK OF TERMINAL.
3. BACK OF TERMINAL SHOULD BE FLAT.
BAD CRIMP - NOT SQUARE
BACK OF TERMINAL
BAD CRIMP - NOT FLAT
.057" +
BAD CRIMP -NOT TIGHT ENOUGH
1140

Figure 7. Connectors

MISCELLANEOUS TORQUE SPECIFICATIONS

Transmission Hydraulic Line Fittings	40-50 ft-lbs (53-66 N·m)
Transmission Flange Mounting Capscrews (7/16"-14)	40-50 ft-lbs (53-66 N·m)
Transmission Mounting Bracket Capscrews	168-196 ft-lbs (227-265 N·m)
Flexplate-to-Crankshaft Mounting Capscrews	50 ft-lbs plus 120 degrees (66 N·m)
Flexplate-to-Converter Mounting Capscrews	17-21 ft-lbs (23-28 N·m)

SPECIFICATIONS

TRANSMISSION ASSEMBLY (B-500/HT-4060)

Manufacturer	Allison
Part Number (B-500 Version 6 W/Series 50)	13G-1-27
Part Number (B-500 Version 6 W/Series 60)	13L-1-189
Part Number (B-500 Version 7 W/Series 50)	13G-1-37
Part Number (B-500 Version 7 W/Series 60/Cat/Cummins)	13L-1-202
Part Number (B-500 Version 8 W/Series 50)	13G-1-42
Part Number (B-500 Version 8 W/Series 60/Cat/Cummins)	13L-1-250
Part Number (HD-4060 Version 6 W/Series 50)	13L-1-197
Part Number (HD-4060 Version 7 W/Series 50)	13L-1-205
Part Number (HD-4060 Version 8 W/Series 50)	13L-1-248

TRANSMISSION ASSEMBLY (B-500R/HT-4060R)

Manufacturer	Allison
Part Number (B-500R Version 6 W/Series 50)	13G-1-30
Part Number (B-500R Version 6 W/Series 60)	13L-1-190
Part Number (B-500R Version 7 W/Series 50)	13G-1-38
Part Number (B-500R Version 7 W/Series 60/Cat/Cummins)	13L-1-200
Part Number (B-500R Version 8 W/Series 60/Cat/Cummins)	13L-1-251
Part Number (HD-4060R Version 6 W/Series 50)	13L-1-193
Part Number (HD-4060R Version 7 W/Series 50)	13L-1-204
Part Number (HD-4060R Version 8 W/Series 50)	13L-1-249

COOLER ASSEMBLY

Manufacturer	Allison
Part Number (Single Pass)	13L-10-174
Part Number (Single Pass)	13L-10-173
Part Number (Double Pass)	13L-10-217
Part Number (Double Pass)	13L-10-218
Part Number (Double Pass)	13G-11-1
Part Number (Double Pass)	13G-11-6

ACCUMULATOR ASSEMBLY

Manufacturer	Allison
Part Number	13L-2-608

CAPACITY SCHEDULE

B-500	Initial Factory Fill: 32 Qts. (30 L)	Service Fill: 25 Qts. (23 L)
B-500R	Initial Factory Fill: 40 Qts. (38 L)	Service Fill: 25 Qts. (23 L)
HD-4060	Initial Factory Fill: 32 Qts. (30 L)	Service Fill: 25 Qts. (23 L)
HD-4060R	Initial Factory Fill: 40 Qts. (38 L)	Service Fill: 25 Qts. (23 L)
	Note: Capacities are approximate only. Please check dipstick levels with the proper “Fluid Level Check” procedure.	*Note: Capacities shown are for 4-1/2” deep oil pan.*

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